Bare Life on Molten Rock

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She laughs to herself, and her whole body shakes with it – she's got a volcano to choke off. So she curls the fingers of one hand into a fist, and sears down its throat with her awareness, not burning but cooling, turning its own fury back on it to seal every breach. She forces the growing magma chamber, back, back, down, down … (N.K Jemisin *The Fifth Season* 2015, 384).

We know surprisingly little about rock. Rock is red hot, creeping, viscous stuff that we rarely see and touch at our peril. For living things like us, to enter into an intimate relationship with the lithic - to become enmeshed with rock - is to become rock. It is to meet with sudden, certain, cessation of life.

At least, that's how it would be if we could encounter the bulk of the Earth's rock. Around 15% of Earth's mass is made up a metallic core, which geoscientists estimate to have a temperature range between 4400 °C and 6000 °C. Most of the rest of the planet – some 84% of its volume – is comprised of the mantle: a slowly churning mix of more-or-less solid rock with temperatures ranging from around 1000° C nearer the surface to 3700° C closer to the core. There are some bizarrely hardy beasts on this planet, microorganisms that have spent billions of years learning to live with high heat. But even the most `hyperthermophile' bacteria can only tolerate temperatures of 120 ° C, a degree of magnitude lower than what would be needed just to brush up against the vast majority of the planet's rock.

There is of course an exception to the unlivable cauldron that is earthly rock. A small proportion of the rocky material of the mantle - at any moment some 1% of the planetary body – has made it to the Earth's surface. Here it cools and hardens in a thin, brittle, excrescence geoscientists call the crust – an outer coating about which they know a great deal more than all the other layers combined. In its exile from the Earth's simmering interiority, crustal rock provides a platform and venue for biological life. Living things can approach, engage, even ingest this minority of minerals. Indeed, here rock and life transform each other, generating composite formations - rocks assembled out of once-living bodies, biological bodies composed in part of minerals. But we should not forget that this florid organic-inorganic interface is but a `gloss on the surface' of our astronomical body (Fortey 2005, 415), and that the stone which invites life's embrace is a chilled and pallid shadow of its seething progenitors.

For perhaps four billion years, life has been denied direct access to its deep wellspring, its basal underpinning. That may be changing. During exploratory drilling of geothermal wells in Iceland's Krafla volcanic caldera in 2009, engineers accidently made contact with magma. `Magma' in geological terminology refers to any molten rock. Along active fault zones magma regularly intrudes into the Earth's crust, where it collects in pockets or `chambers', and occasionally bursts through to the surface. At just over two kilometres down, Krafla's magma body was higher than expected, and the fact that the encounter did not have explosive consequences has attracted attention from volcanologists and geothermal engineers worldwide (BGS 2017).

Researchers are interested in the geothermal potential of magma chambers, which could generate up to ten times the energy of conventional boreholes. More speculatively, the new international research facility at Krafla has begun to explore the possibility of placing sensors directly into magma and even deliberately cooling molten rock – with implications for meliorating volcanic hazards. The research team has no illusions about the trouble they might be stirring up – being at once aware of the `spectacular' danger of triggering eruptions and the more insidious risk of mobilising harmful subterranean chemical elements such as mercury and arsenic. `In spite of studies of the magma, well testing and modelling', geologists report, `the thermo-hydraulic nature of the reservoir at Krafla has remained enigmatic' (Scott et al 2015, 2).

`Enigmatic' is an understatement. Only twice before – both times on the highly active volcanic chain of Hawaii - have human agents encountered magma *in situ*. Geologist Bruce Marsh speaks of the significance of a 2008 magma strike at the Hawaiian Puna Geothermal Venture: `As scientists, we've hypothesized about the nature and behavior of magma in literally countless studies, but before now the real thing has never been found or been physically investigated in its natural habitat within the earth' (cited in John Hopkins University 2008 u.p). For all the digging, drilling, blasting of the Earth's surface that humankind as engaged in, noone has ever made it through the crust into the mantle. There has been no direct observation of the sub-crustal planet: no probes, no samples, no images. Muses geologist Iain Stewart: `More is known about outer space than about what lies deep beneath our feet' (Stewart and Lynch 2007, 70).

While geoscientists contemplate `first contact' with the inner Earth, humanities scholars are beginning to maneuver the missing masses of stone, rock, mineral into their own disciplinary domains. Even over the course of several decades of resurgent materialist thought, the lithic has rarely faired well – being ostensibly light on the agential, vital or life-like qualities that we social and cultural thinkers are ever-more willing to attribute to our fellow creatures and cleverest machines. In a context in which certain kinds of human agency are understood to be leaving permanent traces in the lithosphere, however, there is good reason to draw `minerality' into the expanding register of ethical and political relating: timely reasons to ask not only what we are doing to rock but what part geological formations and processes may themselves have played in the `becoming geologic' of the human (Clark and Yusoff, 2017).

But as rock belatedly rolls into cultural and philosophical inquiry, we need to be attentive to the terms on which it is offered admittance. Whereas the living, the biologic, the organic is a realm in which, by definition, `we' are inseparably inter-twined, the lithic is at once implicated and alien, intimate and untouchable. While the collisions with magma at Krafla or Puna may seem paradigmatic of a mutual and deepening social-geologic entanglement, we might also read this in a very different way. This accidental, potentially deadly communion *is an event* precisely because – in both socio-historical and geological terms – it is utterly exceptional.

The slender boundary that keeps biological life and molten rock apart has of course being pierced many times – a traffic that is vital for sustaining the envelope of life. But this relationship has always been played out on the terms of the inner Earth, never those of the denizens of the crust. It is this fundamental asymmetry, this unilateral exposure of human and other living bodies to forces far beyond their control, that I am referring to here as bare life: the constitutive vulnerability all living beings to the boundary-breaking exertions of the Earth itself. Or something like what Michel Foucault refers to as `the pure naked experience of the outside' (1989, 27).

But it is in the course of this nakedness - this inescapable susceptibility to the seething lithic power of the Earth's interior - that things get strange and interesting. For living beings have also found ways to dwell alongside, and even to enfold and absorb something of the very forcefulness that would annihilate them. As a genus and species, we humans have made a specialty of working with forces that we can barely gaze upon, let alone touch. And it is from this eventful history of negotiating a deep, unfathomable divide that we might look for hints as to how to conduct our future exchanges with rock in its `natural habitat'.

Mantle + Magma

We are all creatures born of heat and pressure and grinding, ceaseless movement. To be still is to be… not alive. (N. K. Jemisin *The Fifth Season,* 2015, 361)

No life form comes close to tolerating the heat of magma. Then again, magma does not last long in our world. `Magma resides inside the earth and lava is its equivalent on the surface', observes Marsh `But once magma erupts, it begins cooling unusually quickly and it loses any gases that it may contain, so it really is a different animal' (cited in John Hopkins University 2008, n.p.). In order for living things to be reprocessed into rock, to enter the lithic strata - they must cease to live. In order for molten rock to enter into the flows and circuits of the outer Earth it must cool, degass, solidify. In short, it ceases to be magma – losing in the process some essential quality for which we do not seem to have a word.

Researchers wishing to study magma before it fully transmutes must move quickly: `grabbing a sample of lava rock or scooping out a blob of semi-molten magma for an on-site temperature probe is still the bread-and-butter work of modern volcano science' (Stewart and Lynch 2007, 70). Aside from the trio of accidental borehole strikes, this means that the study of magma mostly awaits its self-directed journey to the surface of the Earth.

The source of most magma is the mantle layer. Mantle rock is mostly solid, though over long timescales it behaves more like a liquid - slowly circulating in currents driven by heat radiating from the Earth's core. It is this convection – often described by geologists as the `motor' or `engine' of the Earth – that drives the movement of the tectonic plates that make up the planet's crust. Both the moving apart of plates and the process of subduction, in which one plate is pushed beneath another, cause rock in the vicinity to liquefy into magma (Rotheray 2007, 11-16).

As well as the great slow-motion convection cycles, there is a fast track of heat to the surface. Upwellings of superheated rock that originate thousands of kilometres beneath the Earth's surface, mantle plumes generate magma when their upward fluming brings them up against the hard underside of the crust (Fortey 2005, 74-5). For geoscientists, plumes explain the presence of volcanic hotspots in places that cant be put down to plate movement - and they have identified over a thousand of them along with a smaller number of monstrous `superplumes'.

Whatever its source, magma rises because its combination of molten rock and dissolved gas makes it lighter that than the rock from which it is formed. But its ascent is usually blocked. When rising magma hits solid crust, it tends to stall: intruding into adjacent rock fractures or pooling in subsurface chambers like those at Krafla or Puna. Here it will sooner or later cool and crystallise into solid rock – or, if there is a sufficient supply line of new magma, mounting pressure may eventually result in volcanic eruption.

Geoscientists believe Earth to be the only planet in the solar system where the transfer of heat and material in the mantle is dynamic enough to be constantly resculpting the surface (Zalasiewicz 2008, 14-18). While the solar-driven interplay of rock, water, air, and life that is the Earth's outer envelope is obviously of great interest, in terms of comparative planetology it is as much the active traffic between interior and exterior that makes our own astronomical body an exceptionally interesting one. By driving plate tectonics, mantle activity constructs the sea floor, builds mountains, rearranges continents and oceans – and in this way sets and upsets the stage on which life performs its more delicate maneuvers (Fortey 2005, 431, 414).

It is the upwelling of magma – or igneous processes, in geological terms - that is the source of the vast majority of the Earth's crust: the ultimate feedstock for the mineral reprocessing effected by life, water, wind, ice and heat. Speaking in particular of the venting through which the interior releases its pent-up matter-energy, science writer Simon Winchester observes:

> It is not merely that volcanoes bring fertile volcanic soils or useful minerals to the surface; what is more crucial is their role in the process of bringing from the secret storehouses of the inner earth the elements that allow the outer earth, the biosphere, the lithosphere, to be so vibrantly alive (2004, 302).

While we in the humanities are currently riding high on the divination of life, vitality, vivacity in all manner of worldly contextures, it may be timely to consider literary theorist Claire Colebrook's observation that `vitalism is …*the* dominant motif in Western philosophy in general' (2010, 43) - by which she means a span of two thousand plus years. Colebrook reminds us that `(n)o living body is the author of itself' (2010, 45). There is no coursing creativity of biological life, no organismic exuberance, no fleshed-out affectivity, she insists, without the `explosive' force of the inorganic.

Even more of an outlier in contemporary cultural inquiry is philosopher Manuel DeLanda's explicit embrace of subterranean generativity. As DeLanda channels the Earth science story of an originary interiority:

> From the point of view of the nonlinear dynamics of our planet, the thin rocky crust on which we live and which we call our land and home is perhaps its least important component. Indeed, if we waited long enough, if we could observe planetary dynamics at geological time scales, the rocks and mountains which define the most stable and durable traits of our reality would dissolve into the great underground lava flows of which they are but temporary hardenings (1995 n.p.)

Or in the words of paleontologist Richard Fortey `We may all ultimately be the children of convection' (2005, 429), an intuition which science fiction-fantasy writer N. K. Jemisin teases out in the complex world-building and more-than-human peopling of *The Broken Earth* trilogy (2015).

Then again, scientific accounts of the subterranean world are themselves a story of sorts - a narrative conjured from remnants, glimpses, guesswork. Even plate tectonics, the pivot around which the integrated understanding of planetary dynamics now hinges, geologist Jan Zalasiewicz reminds us, `is … still just a hypothesis' (2008, 48). For all that it looms large in the Earth's mass, geologists disagree about the structure of the mantle. Some believe that subducted slabs of continental crust sink through the upper mantle into the depths of the lower mantle. Others argue that the zone of transition between upper and lower mantel prevents lithic matter falling into the depths and that the lower mantle is largely unmoving (National Geographic n.d, n.p). Mantle plumes are no less controversial. A recent counter-hypothesis denies their very existence, proposing that mid-plate volcanoes are better explained by the ordinary, pre-existing molten rock taking advantage of stretching and fracturing in the crust (French and Romanowicz 2015)

The natural sciences are no strangers to contested terrain. But the uncertainty surrounding fundamental geodynamic principles is a reminder of the extreme accessibility problems posed by the fomenting bulk of our planet. Alongside snaffling lava in its fading moments, geologists interrogating the inner Earth must rely on fieldwork in solidified `fossil' magma chambers, laboratory recreations of subsurface conditions and, most importantly, the analysis of seismic waves generated by natural earth tremors as they pass through the planetary interior (BGS 2017).

The technique of seismic tomography is based on the comparative study of signals from earthquake monitoring stations around the world. Variations in the timing and direction of the seismic wavefront are used to reveal discontinuities in the heat, structure and composition of the material through which it has passed (French and Romanowicz 2015). Because there are so many subterranean `inconsistencies' that can slow or deflect waves, tomographic study is fraught with ambiguity – though the application of supercomputing to seismic analysis appears to be advancing the 3D modeling of the mantle (Pratt 2015).

But what does it say about our relationship to the Earth that we depend upon seismic upheavals as our main medium for making sense of most of the planet's mass? Much has been said the deathly dissections and disjointing that Enlightenment science has deployed to prise the secrets from the nature of things. While this sense of destroying in order to comprehend may well apply to the finer detailing of terrestrial existence, it as if these power-knowledge relations are inverted when it comes to the deep Earth. For the forces we must turn to disclose the inner Earth belong to the planet itself – and they are the very forces which most threaten to destroy us, and the worlds we construct for ourselves. In other words, it is the inquirer who must dice with destruction in order to glimpse an object that remains fundamentally indifferent.

This is a planet on which a shell of solidified rock – a slender firewall - is all that separates us and fellow creatures from a world of unbearable heat, pressure and motion. At the same time, our existence and the continuity of this crustal dwelling place is utterly dependent on its periodic puncturing, its replenishing by the matter-energy beneath. To even begin to comprehend this relationship, we must huddle around the hot spots, the fracture zones, the fiery portals between surface and underworld. Small wonder then that volcanology - the study of igneous processes - is one of the deadliest fields of intellectual inquiry: a subdiscipline premised on stealing up on life-extinguishing forces.

Becoming Igneous

The sunset glow of molten iron bewitched him, the way the color emerged in the stock slow and then fast, overtaking it like an emotion, the sudden pliability and restless writhing of the thing as it waited for purpose. His forge was a window into the primitive energies of the world…. Liquid fire was the very blood of the earth. (Colson Whitehead *The Underground Railroad* 2016, 73)

The intuition that much of what is valuable in the world comes out of movement, mingling and admixture has meant that much recent critical thought looks upon hard-edged boundaries - whether political or ontological – with suspicion. As the imaginary architecture of prejudgment and exclusion, grand conceptual divisions – dualisms, binaries, dichotomies – are seen to be especially reproachable. But as social theorist Vicki Kirby counsels, as we go about our troubling of binary logics we should keep in mind that acts of division can also be generative and sustaining of difference. `Cutting, or differentiating, is not a mistake,' she proposes: `it is the implication that *is* productivity' (1999, 28). And it is not only we `social' or `cultural' agents who divide things up, Kirby contends: the world itself can be conceived `as a "unified field" of operational differentiations' (2011, 66).

The establishment of a structural divide between molten interior and clement, sunlit crust, I am suggesting, might be seen as the Earth's first and greatest binary gesture, the planet's primordial `operational differentiation'. On the seething magma ocean of the new-formed Earth, geoscientists recount, patches, and later plates, of solidified rock came relatively early, as did the deep-seated convection currents that propelled nascent crust into motion (Zalasiewicz 2010, 23-24). By the close of the Hadean eon – some 600 million years after the congealing of the planetary body, there are already hints of biotic life on the outermost Earth.

From the outset, injections of matter-energy from the inner Earth seem to have played a vital part in the emergence and proliferation of life. Degassing of masses of volcanically ejected magma helped form the oceans, and there is an argument that the earliest life may have been heat-loving microorganisms clustered around marine vents or hot springs (Margulis and Sagan 1995, 69). But if the convection of super-heated mantle rock is indeed the `motor' of the Earth, it by no means idles steadily. At various junctures in Earth history, vast eruptive events have impacted brutally on the spread and diversification of life, cutting short the trajectory of whole branches of life millions of years in the making – while also opening up new evolutionary opportunities.

For at least the first two billion years, terrestrial life – indeed the very operation of biosphere – was dominated by single-celled organisms of the archaea and bacteria domains, small but by no means simple (Margulis and Sagan 1995, 68-72). It has been proposed that what finally enabled another domain of life - larger, multi-cellular organisms - to come out the shadows of their microbial counterparts was a massive effusion of magma. Around 1.9 billion years ago, a recent hypothesis suggests, huge volumes of molten rock were pumped into the crust by a hyperactive mantle plume (Parnell et al, 2012). As it stalled and pooled in subsurface chambers, this magma became enriched with metals. Bursting out across the surface of an ancient landmass in the form of vast lava flows, it soon cooled and solidified into granite. And as this granite gradually eroded over the next few hundred million years, it released exceptional quantities of trace metals into shallow, watery environments rich in biotic life.

Absorbed into the body, tiny qualities of metals such copper, zinc and molybdenum help organisms perform basic metabolic reactions – quickly and efficiently. The influx of trace metals during the mid-Proterozoic eon served as a boost to life - a massive subsidy to the surficial life world from the mineral superfluity of the underworld. While it benefitted all types of life, the sheer excess of bioessential metallic elements gave organisms with more complex cell structures a chance to compete with simpler, leaner, faster–foraging microbes – paving the way for the proliferation and diversification of the former. As geologist John Parnell concludes: `It was the introduction of the metals into these single-celled organisms that changed their chemistry and allowed them to evolve into the complex multi-celled organisms which were the first step towards more diverse life on Earth' (University of Aberdeen, 2012, u.p). Ultimately, but by no means inevitably, this magma-fuelled irruption of life gave rise to algae, plants, fungi and animals – in other words, the visible, multicellular organisms that most of us have in mind when we think of `life'.

Successive setbacks and advances followed – some volcanic in origin, others triggered by extraneous events - such as asteroid impact. The vast, long-lasting Siberian Traps eruptive event at the Permian-Triassic boundary some 250 million years ago played a part in the die-off of an estimated 90% of the Earth's species, while the Deccan Traps lava flood is implicated in the mass extinction at the boundary of the Cretaceous and Paleogene periods some 60 million years ago. Both upheavals are attributed to mantle plumes. For all their brutal and generalised winnowing of life, each extinction event is also seen to have offered opportunities for the proliferation and divergence of certain classes of biota. In the case of the Deccan traps this included birds, fish and mammals, and amongst the latter, the order of primates.

Though deeply imbricated with its cool, crustal stone-world, terrestrial life of all varieties remains exposed to the bursts of superheated rock from below. But just as the Earth composes a crust, a casing, around the unlivable energies of its interior, so too do all organisms establish a boundary between self and world - a skin, shell or husk that enfolds its metabolic system. Through this membrane passes the organic and inorganic matter through which the living body sustains itself, an exchange that must be controlled enough to hold the potentially overwhelming forces of the outer world at bay - but loose enough to admit the stimuli that can trigger transformation.

In one such set of negotiations, a genus of primates inhabiting a volcanically active region seem to have developed ways of living with igneous processes that were new to the living world. According to some geological storylines, the East African Rift System is a site where one or more mantle plumes – perhaps a single superplume – rises up beneath a stretched and splitting landmass. The resulting landscape is a complex mix of escarpments and canyons, fertile valleys and plentiful water bodies, punctuated by jagged, formations of solidified lava pumped out of numerous volcanoes. According to geophysicist Geoffrey King and archaeologist Geoff Bailey (2006), Africa's Great Rift offered not only a nutrient-rich environment, but also shelter for an agile, though relatively defenseless, ground-dwelling primate. In particular, they suggest, lava fields – as well as providing a wealth of lithic material for tool-making, offered a kind of natural palisade, where hominids could take refuge from predator species.

But there is another affordance offered by volcanic effusion. As Bailey, King and Manighetti speculate: `Very early evidence for the use of fire remains controversial, but the association of early hominid activity with volcanically active areas would certainly have enhanced the possibilities for observing and making use of the benefits and effects of fire and heat' (2000, 43). Building on this observation, geographer Michael Medler is more explicit, proposing that is from living in proximity to lava flows that hominids learnt how flame ignited vegetation, and `may have learned quite early to stay near these fires and add fuel to the fires' (2011, 20).

Given the intense interest in the origins of the genus *Homo*, it's surprising how long it took for igneous activity in the ancestral neighborhood to attract any real attention. If this is indeed a planet upon which the operational divide between seething interior and relatively solid crust has a special significance, then it would seem to make sense to ask how our species - and its near relatives – have negotiated this juncture. And if we are to push the question of how it is that our species has become a geological agent, then we might do well to consider the extent to which our ancestors may have helped define themselves through a peculiar or extreme affinity with those sites where the `liquid fire' of the molten Earth breaks through to the surface.

Well before the spate of Earth system changes that have lately sparked the `Anthropocene' debate, there was another set of anthropogenic interactions with the igneous Earth that invite for our attention. At numerous sites in the ancient world –

often close to sites of active volcanism – artisans engaged in a series of highly successful experiments using concentrated heat to change the structure of inorganic matter. The key to this innovative spree – that spanned much of the Holocene epoch and spread across several continents – was the controlled use of fire in purpose-built chambers.

`Pyrotechnology' is the collective term that refers to the use of heat in ovens and kilns to produce ceramics, plaster, concrete, metal and glass: the materials from which much of the so-called `civilized' world has been constructed (Wertime 1973; Clark, 2016). Over thousands of years, craftspeople learned to crank up their homemade furnaces to temperatures that reached over 1500 °C – a level which exceeds the heat of lava and the upper mantle. With no knowledge of the way volcanoes operated, no access to the subsurface pooling of molten rock, artisans in a strangely intuitive way managed to reproduce with their own chambered fire many of the igneous processes at work in magma chambers. They melted and recrystallised rock, metamorphosed minerals, formed new compounds, decomposed and concentrated metallic ores. Or as a writer depicts the culminating moments of a contemporary artisanal iron smelting: `the furnace is pierced to release the liquid slag – which pours out like volcanic magma, and cools to form a brittle, crystalline crust' (Chowdry, 2014: u.p.)

The pyrotechnologies that took off some nine or ten thousand years ago are surely one of the originary sites of what is today referred to - perhaps too easily and indiscriminately - as human geological agency. Spending their working lives with just a few inches between them and temperatures of magmatic intensity, the fire-wielding artisans of the ancient world accrued a deep, working knowledge of the transformational pathways of molten rock. In the process of transmuting soggy clay into durable ceramics, crumbled ores into lustrous copperware, gritty sand into translucent glazes and glass, they often paid the price for summoning the powers of the inner Earth. Like magma chambers, kilns could rupture or explode, exposing bodies to burns, blindness or death, bringing blazing ruin to whole quarters or towns (Gouldsblom 1992, 110-111).

Unsurprisingly, pyrotechnicians looked to strong and artful gods, deities who as a rule presided over both volcanic and artisanal fire. The Greek Hephaestus was the god of fire, potters, blacksmiths, metals and volcanism, his Roman counterpart Vulcan lorded it over forges, metalworking, fire and volcanoes (Goudsblom 1992, 110). Egyptian demiurge Ptah was the god of metalworkers who also embodied underground fire, the

Etruscan Sethlans commanded fire, smithing and volcanoes, while in Yoruba mythology, Ogun - born of a volcano - was the god of iron and metalworking.

Inheriting perhaps a million years of hominid manipulation of fire, pyrotechnology might be seen as kind of circling back on the volcanic milieu of the Great Rift Valley. With no possibility in sight of reaching through the crust to the planet's simmering interior, artisans found a way to reproduce something of the Earth's inner heat engine, to forge magmas and lavas of their own, to literally *become igneous*. More than simply connecting with stone, pyrotechnical operators developed an intimacy with the very processes through which stone itself was formed, shaped, transmuted. But always, on pain of death, they had to work across a great divide, respecting – and recreating for themselves – the originary division that keeps the tender intricacies of life living apart from the monstrous churnings of molten rock.

Magmatic Futures

But why do you want to power magma crucibles (assuming you're making lava)? Why not power whatever you want to power with the magmatic engines directly? (Hydra, FTB May 7 2013)

I'm pumping the lava into a thermal generator, as stated in the beginning, to power an MFE (Multi-Functional Electric storage unit) for my machines (Nemorac, FTB May 7, 2013)

We're not talking about a magma crucible as part of a power plant. I'm talking about a magma crucible as a means to make lava. Do you know of any uses for lava beyond fuel? I do. (Enigmius1, FTB Aug 12, 2013)

The crust trembles and the geo-pyrotechnic deities gather for a comeback. While Earth scientists and geothermal engineers convene at the rim of the caldera, pondering whether to take the plunge into the magma chamber, popular culture lines up a pantheon of liquid-fire wielding superheroes and villains. The *Superpower Wiki* site lists more than forty contemporary fictive characters with magma-manipulating faculties - from Darksider's `Abyssal Forge', through Marvel's `Magma' and `Molten Man' to Skylanders'

`Eruptor'. Then there are the `orogenes' of N. K. Jemisin's *Broken Earth* trilogy – a complex, fully rendered human minority group defined by their in-born power to intercede in seismic and volcanic processes. But perhaps it is the aptly monikered Enigmius1, in a forum dedicated to the video game Minecraft, who most frankly – if inadvertently - lays down the challenge to the projects of Krafla or Puna, with the question: *Do you know of any uses for lava beyond fuel?* (FTB, 2013).

For the lesson we might take from the long history of magmatic encounters – from the catalysing influx of bioessential metals during the Proterozoic through to the igneous experimentality of Holocene pyrotechnology – is that the inner Earth is above all a source of potentiality. Far from the modernist imputation of stasis and grounding to rock, the dynamical possibilities of molten rock - as DeLanda suggested - always exceed their actualization in chunks of stone or stratal layers. By the same logic, there is a lot more to the liquid fire of the inner Earth than its monstrous energy: to be `children of convection', `*creatures born of heat and pressure and grinding*' is not simply to be powered but to be nourished, catalysed, provoked.

Born of the hyperactive volcanic landscape of the Rift Valley, the genus *Homo* - after several millions of years of fiery evolution - circles back on the volcanic hotspot. If the chambered fire of the artisan was a kind of folding in or capturing of volcanic power, then intentional drilling into magma might be viewed as a sort folding out, the moment in which we take the faculties that we have borrowed from the inner Earth - that we enclosed, entrained, intensified - and turn them back upon their source. To put it another way, if the oven or furnace was our volcano, perhaps we are on the verge of making a kiln of the magma chamber.

Which brings us back to Enigmius1's challenge. If people we think of as `ancient' or `premodern' could conjure breathtakingly beautiful and profoundly useful objects from a few scoops of melted mineral, what might we imagine ourselves doing if we can access great caverns of molten rock?

Important aspects of the social negotiation with the mineral, the igneous, the magmatic have, of course, changed greatly since the high era of pyrotechnological innovation. Many of us now spend a good deal of our working and playing lives as participants in increasingly complex computational worlds. But it's worth keeping in mind that the informational edifice remains deeply dependent on a mineral substrate of silicon, copper, lithium, bauxite, tin, rare earth metals (Cubitt, 2017): materials that are more often than note converted into usable forms through pyrotechnical operations (the dual damascene process, for example, in which copper patterning is applied to silicon chips, references a Bronze Age metalwork technique of inlaying silver and gold)

Both the ubiquitous integrated circuit and optical fibres – with their currently installed capacity to encircle the Earth some 16,000 times – have as a core component silicon (Cubitt 2017, 96), the second most abundant element in the Earth's crust after oxygen. And all this silicon - the basic ingredient of sand, quartz, feldspar and granite - has at some stage been pumped out of the mantle: a layer composed largely of silicate minerals – which is to say, compounds of silicon and oxygen. Quite literally, as a recent article on microprocessor assembly quipped: `(t)he whole business is built on sand' (Marshall, 2016 u.p.). This sand, in turn, being composed of solidified and disassembled magma.

In an intervention aimed at curbing some supposed excesses of the recent `speculative' turn in philosophical inquiry, Steven Shaviro offers the timely reminder that we still live in a world shaped and rocked by geologic events: `The volcano is actual, here and now; we cannot expect to escape its eruption' (2011, 290). At the same time, however, Shaviro stresses - contra those who would affirm obscure, withdrawn core of the object world - that prolific digital transcoding and dissemination means that everything in the world is now exposed, reproduced, circulated: `Nothing is hidden; there are no more concealed depths' (2011, 289).

There is, to be sure, a lot of unconcealment going on. An estimated 3.5 million digital photographs are now shared online *every minute* (Parrett 2016 u.p.). But it's worth pausing to consider that out of the 2.5 trillion snapshots that will be uploaded this year, there is unlikely to be a single one depicting the sub-crustal Earth. To put it another way, well over 99% of the mass of our planet is totally excluded from this informational exposure – and that includes the `natural habitat' of all the silicon that makes this hyper-circulation possible. And it is precisely this indifference, this excess of the inner Earth that leaves us carbon life forms - intricate and delicate as we are – exposed to its upheavals.

If it does become possible – for the first time - to probe beneath the lithic crust, it will be an achievement that builds on several billion years of exploratory and compositional work with the materials disgorged by the fiery interior of our planet - an experimental process that seems to have been hotting up since hominids emerged from the igneous terrains of East Africa. While it may be too soon to answer Enigmius1's question about what else could be done with lava, the actual forms this might take seem likely to emerge from our growing fusion with silicon. But so too will they draw upon our multi-millennial experimentation with other kinds of rock – much of it molten. Given our barely diminished nakedness in the face of the planet's churning interiority, should we succeed in transgressing the inner-outer Earth boundary, we might do well to pay our respects to the old and new gods of liquid fire.

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