What can a planet do?

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Abstract: In this article we build on recent 'geo' themed work in human geography to move beyond the Earth and consider what our own planet shares with other astronomical bodies. Mobilising ideas from the planetary sciences, we sketch a speculative philosophy of planetary evolution in three steps. First, we develop an idea of 'the planetary' that sees planets as ongoing processes and sets of relations stretched over space and time. We then consider 'the intraplanetary': how planets develop internal self-difference and evolve their own unique identities. From there, we turn to 'the multiplanetary', exploring in the broadest way how planets might come to forge new kinds of interplanetary relations. We conclude by asking how the idea of a planetary becoming 'without return' might help us think more expansively about human interactions with other astronomical bodies – and with our home planet.

Introduction

If recent turns in more-than-human geography have been calling for the titular 'geo' to do more substantive work, so too have researchers in our own and cognate disciplines been insisting that taking the Earth more seriously also implies looking beyond our home planet.[1] The tasks of earthing and un-earthing social thought, as we might say in the wake of Valerie Olson and Lisa Messeri, seem increasingly inseparable.[2] One of the key incentives for locating and eventually settling habitable 'Earth-like' planets is perceived threat of cataclysmic events that would jolt the Earth out of its current operating state and into a new and perhaps unliveable condition. But more-of-the-same is not the only storyline. Another recurring theme in both the advocacy of and research into moving 'off-world' is the possibility that inhabiting extra-terrestrial environments might propel our species along a novel trajectory – such that we would eventually turn into something other-than-human.

Though they are often culturally or political inflected in dissimilar ways, the Earth-at-risk and the becoming post-human scenarios share a basic assumption. Whether the body is biological or astronomical, they infer a capacity to differentiate or become other to itself, which in turn implies that the entity in question is something more than self-same or a simple unity. Most social thinkers, we suggest, are familiar with the idea of *human* difference or multiplicity; the sense that there are both many variations on the theme of being human and that none of us is locked into one version. Such claims underpin critical social thought's prevailing response to the Anthropocene: the charge that earth scientists habitually diagnose the planetary predicament on behalf of all humanity and in the process disregard the diversity of human experience – including the full range of ways that different cultures or communities make their own sense of an earthly abode.[3] But critical commentators have tended to be less interested in planets with the capacity to become otherwise or to consider how human multiplicity might express or encapsulate a broader 'planetary multiplicity'.[4]

In this short intervention, our focus is on the potentiality of planets to self-differentiate, to acquire new capacities or to lose capabilities they previously exhibited. In short, we ask what planets do, both alone and by way of their relations with other astronomical bodies. This is hardly a novel question. Many, perhaps all, human cultures have inquired into the nature of their terrestrial grounding and pondered its relationship with extra-terrestrial phenomena. Noting the difference between their own and western accounts of Earth and its beyond, voices from other cosmologies have long been both resisting and reworking other visions. As Indigenous Australian Tyson Yunkaporta explains his own Bama people's approach:

> We yarn about the sentience of stones and the ancient Greek mistake of identifying 'dead matter' as opposed to living matter, limiting for centuries to come the potential of western thought when attempting to define things like consciousness and self-organising systems such as galaxies. They viewed space as lifeless and empty between stars; our own stories represented those dark areas as living country, based on observed effects of attraction from those places on celestial bodies.[5]

So too, should we of the west be alert to our own borrowings from others, as geographer Adam Bobbette has encouraged us to do in his analysis of two-way exchanges between western geoscience and local cosmologies in the geologically hyper-active landscapes of Java.[6] While attentive to ontological 'pluriversality' and perviousness, the task we set ourselves in this paper is primarily a reckoning with our own onto-epistemic inheritance. For us, this means working with and through the offerings of more-or-less western but rapidly globalising planetary sciences: not so much because we credit them with them with the last word on comprehending the cosmos, but because of the potential for collateral use, repurposing and extrapolation that we find in the material they present. In this way, we move back and forth between the natural sciences and certain strands of continental philosophy to offer a *speculative account of planetary evolution* – a preliminary step both for responding to the kind of cosmological provocations Yunkaporta offers and for our own cultural reimagining of extraterrestrial space as 'living country'.

Our previous work on 'planetary multiplicity' tracked developments in the geosciences from the late 1960s that at once documented the Earth's functioning as a single integrated system and came to recognise how dense interconnectivity enabled the planet to periodically self-organise into a new overall operating state.[7] We have also been inspired by Gilles Deleuze's concepts of 'internal multiplicity', 'non-oppositional difference', or 'difference in itself'.[8] And like Deleuze, we have drawn on Gilbert Simondon's notion of a self-transformative capability that arises out of tensions inherent in matter: the idea that beings can have the capacity 'of falling out of step with themselves, … of resolving themselves by the very act of falling out of step'.[9] We are further indebted to Gayatri Chakravorty Spivak's prescient framing of planetarity.[10] Building on her own critique of a structurally rifted globalization, Spivak took up Derrida's logic of the generative but risky encounter with the 'irreducible exteriority of the other' and pushed it far beyond the orbit of the human.[11] For her, our planet's abyssal capacity to become other to itself is an inescapable underpinning of human difference: planetarity being the condition of our exposure to an inhuman otherness that we will never fully recuperate or comprehend. As 'planetary creatures' observes Spivak, "…alterity remains underived from us … it contains us as much as it flings us away".[12]

Over recent decades, geographers and neighbouring social thinkers have increasingly concerned themselves with the interchange between human lives and an array of ecological, geological and physico-chemical, processes – often in ways that resonate with Spivak's presumption of the insuperable excess of inhuman forces. Bodies, cultures, worlds, this work has shown, constitute themselves out of their manifold relations with more-than-human materialities: each human organism or collective viewed as a variable constellation of the extraneous elements it has encountered, enfolded and elaborated upon[13]. To extend these dynamics into extra-terrestrial realms, we suggest, calls for a specific and systematic focus on the planetary scale.

Research around such themes as viewing the Earth from space, inhabiting Gaia or the living planet, human impacts on Earth systems, geoengineering, and planetary stewardship have already extended more-than-human discourse to the level of the planet. In different ways, Bruno Latour's marshalling of the Gaia hypothesis to reimagine social science as explicitly 'earthbound' and Dipesh Chakrabarty's negotiations between Earth systems science and critical global studies have provided influential mediations between social and planetary discourses.[14] Building on intimations from both Latour and Chakrabarty, Lukáš Likavčan takes a significant further step, and asks what it might mean to commence our planetary thinking not from the familiar contours of Earth but from a consideration of planets in a generic and comparative sense. In short, he invites social scientists and humanities scholars to institute their planetary perspectives by drawing on 'the astronomical legacy of thinking about planets as members of a specific category of celestial bodies.'[15]

Along similar lines as Likavčan, we take the idea of a cosmic extrapolation of critical thought as an invitation to move beyond the particularity of our home planet, and to ask both what is distinctive about Earth and what it shares with planets in general. We begin by inquiring what kind of entity or category of being a planet is, before moving on to the matter of how each planet discovers or evolves its own identity. We then consider how planets relate to each other and what it might take, as one possible trajectory of planetary self-differentiation, to forge new kinds of interplanetary relation. This brings us to the question of how a movement along a unique astrophysical pathway – a planetary becoming 'without return' - might help us to think about human interactions with other astronomical bodies and the possibility of our own irreversible cosmic venturing.

The planetary

We begin with the rather obvious observation that planets differ from each other, and from other astronomical entities – numerically and qualitatively. Astronomer and historian of science Stephen Dick proposes a comprehensive classification of the entities of the cosmos in a hierarchical system of Kingdoms, Families, Classes and Types, analogous to Linnaeus's eighteenth-century classification of living organisms.[16] We want to use Dick's 'natural history'[17] approach to astronomical entities as a point of departure for a conceptualization that focuses more on process and relationship, consistent with Deleuze and Guattari's 'geophilosophy' with its logic of the 'inclusive disjunction', in which things can be 'both–and', and with Simondon's insistence that we should see the ontogenesis of individual entities as an endless process of becoming, and thus a concrete individual planet as only an effect or phase in a far wider process and set of relations.[18]

Dick first divides astronomical entities into three 'Kingdoms', each with a prototypical astronomical object at its heart – galaxy, star, planet. He further divides each Kingdom into six Families: "the eponymous object itself and five other Families denoted by prefixes representing their gravitational relationship to the central categories of planet, star or galaxy".[19] Thus, when telling the story of a planet, we will typically find ourselves having to refer to entities belonging to many of the Families in Dick's planetary Kingdom – not just the planet 'itself', but also the protoplanetary (the disc out of which the planet formed), the subplanetary (objects that share only some features of planets), the circumplanetary (any moons or discs around the planet), the interplanetary (gas, dust, wind and rays) and the circumstellar planetary system (including belts and clouds of asteroids, meteoroids, Kuiper and Oort objects).

Let us start at the literally nebulous origin of planets. As the science of astronomy informs us, planets originate in an immanent solar nebula: a spinning protoplanetary disc of hydrogen, helium and metals. If the right sort of fluctuations occur – generated largely by the dynamics of the rotating disc itself – these disrupt the latter's homogeneity, and can trigger a process whereby the disc organizes itself into separate clusters of matter: 'planetesimals', which can subsequently form 'planetary embryos'. These may in turn evolve into full-blown planets: dense, approximately spherical bodies with their own gravitational fields that, as they clear out or combine with smaller objects in the vicinity, come to dominate an orbital region around their star. Planets thus *fall into being* as they self-assemble, creating their own gravity wells, which generates a local 'down' along which things can fall. In this way they become 'places' within the emerging circumstellar system, and gain the possibility of acquiring circumplanetary moons and discs.[20]

This process of becoming a 'place' comes with complications, however. Spivak's refusal to "offer a formulaic access to planetarity" can be brought into resonance with geophysicists Morbidelli and Raymond's overview of the "mysterious subject" of planetary emergence, which concludes with the admission that "even our most successful models are built on a shaky foundation".[21] While planetary origins may not be as obviously complex as the processes involved in abiogenesis (the emergence of living things from non-living matter), the way that a planet makes itself and opens up radically new spatial relations might be considered as metaphysically provocative as the advent of organic life.[22]

As Dick observes, unlike stars and galaxies, which exhibit a huge diversity of form, members of the Family of planets seem constrained to settle into one of three planetary Classes – rocky, ice giant or gas giant.[23] This trifurcation of planets into Terran, Neptunian and Jovian worlds suggests that there are unstable 'saddle points' in the mass of forming planets that divide the possible futures of emerging worlds. In Deleuzian terms, we might say that all planets in theory contain the same virtual structure of singularities and possibilities that belong to the Class of planetary objects and are simply separate 'actual' instantiations of it.[24] However, because of the way that planets in their forming follow a particular developmental course, it is truer to say that they each instantiate a particular subset of that common virtual structure.

Even after a planet has settled into one of the three Classes, it will continue to develop along its own unique pathway. To understand how this process of planetary individuation proceeds – how a planet explores the potentials of its own multiplicity – we turn from the broader realm of astronomical categories and processes to the particularity of the 'intraplanetary' domain. Here the question of what we should and perhaps should not learn from our home planet looms large.

The intraplanetary

Just as it plays a dominant role in the formation and dynamics of galaxies, stars and planetary systems, gravity is the main force that determines how a planet organizes itself into differentiated strata, compartments or spheres.[25] Through gravitational collapse within a still-congealing planetary body, diverse chemical elements find their level and adopt different phase states (solid, liquid, gas) and mineral type according to the temperature and pressure in that part of the planet. This results in vast, extended regions of solid, liquid or gaseous 'continuous matter', often without clear borders or interfaces, comprising subsystems that operate on different timescales.[26]

But this is far from the end of the story. Ongoing flows of energy from their parent star (if they remain part of a solar system) and from their own hot core tend to prevent a planet from descending into equilibrium, leaving its differentiated layers or spheres crosscut by intensive gradients of pressure and temperature.[27] From time to time, these ongoing, dynamic relations propel planetary sub-components across symmetry-breaking bifurcations into new configurations. In this way, planets may pass through a succession of wrenching transitions, involving the generation and recombination of diverse constituent entities and substances.[28] It is by way of such 'revolutions' that planets may gain (but also sometimes lose) the capacity to do things of which they were previously incapable.[29] To only list some planetary potentialities that we know about, planets with active interior dynamos generate powerful magnetic fields which mitigate the effects of cosmic and solar radiation; planets variously assemble atmospheres, hydrospheres, cryospheres, and in at least one known case, a biosphere; planets develop their own unique weather systems and surface processes; rocky planets may evolve mantle convection cycles which function as vast heat engines, helping drive plate tectonics; some planets evolve complex ring systems, others produce diverse lithic strata.

Earth's evolution of biological life is the perhaps most celebrated example we have of a planet acquiring novel capabilities. But the presence of life on our own planet is so ubiquitous and consequential that it is hard to see beyond it, or past its peculiarities. In this regard, we should heed geophysicists Michael Summers and James Trefil's prompting to ask how biological evolution might proceed on a tectonically inactive planet, without the either the challenges or the opportunities presented to terrestrial life by the ceaseless perturbation of the Earth's surface. Furthermore, we should take seriously their suggestion that planetary surfaces like ours that are directly exposed to ultraviolet solar radiation might be unusual places for ecosystems to emerge and survive, and that most life in the galaxy might live in subsurface oceans within planetary interiors.[30]

At a smaller scale, philosopher of science Carol Cleland has observed that the Terran DNA molecule is so bizarre and unlikely that it is probably a result of very specific conditions on the early Earth, making it very hard to foretell whether other molecules performing similar functions could arise elsewhere.[31] Indeed, Cleland hypothesises that there may have been more than one form of biological life in Earth's history, but that the others were outcompeted or absorbed – while she adds that if traces of a parallel microbial ecosystems did persist, our current instruments would not be good at detecting them. She suggests that we might find clues as to the possible forms of alien life in terrestrial phenomena that seem to fall between the biological and nonbiological: desert varnish, a thin coloured coating found on rocks in arid areas; 'nanobes', tiny filamental structures found in rocks and sediments; or the red rain of Kerala, speculated as extraterrestrial in origin. To this we might add the 'trovants' of Romania, rock concretions that grow, reproduce and are even claimed to move.

Moving further from a Terran-centred enthrallment with biological life, science fiction writer Stanislaw Lem speculated about what matter might achieve on lifeless planets. As he wrote in the novel *Fiasco*:

> It was only in places … where neither the sieves nor the mills of natural selection were at work, shaping every creature to fit the rigors of survival, that an amazing realm opened up—of compositions of matter that did not imitate anything, that were not controlled by anything, and that went beyond the framework of the human imagination.[32]

There are resonances here with the seemingly paradoxical notion of 'nonorganic life', first posited by art historian Wilhelm Worringer, but developed and popularized by Deleuze and Guattari – for whom it refers to an inherent capacity of matter to propel itself across thresholds into new levels of organization and novel functional assemblages.[33] In a variation on this theme, historian of science and technology Thomas Brandstetter delves into both science fiction visions of noncarbon-based aliens and biological science research into the indeterminate zone between living and inanimate matter to trouble the assumptions behind the search for conventionally conceived extraterrestrial 'life-forms'.[34]

Beyond defining or searching for life, what interests us is coming to appreciate the multiple ways that a planet might pass through a bifurcation and become other to itself. It is about considering how capabilities acquired or lost in such events may be variations on the theme of Earthly 'revolutions' or state-shifts of planets with which we are familiar – while also leaving open the possibility that they could involve forms of emergence that we would as yet struggle to recognize.

Along these lines, planetary sciences – not without controversy and contestation – propose that over vast intervals, each planet has to discover its own unique version of planetarity without the benefit of inheriting form or identity from other planets. For much of this time, as a planet explores the possibility space available to it, isolation in the void plays a crucial role: interaction between planets is mainly gravitational and most of the interesting transformations, we have been suggesting, are intraplanetary. But prior to this lengthy period of relative material closure, multiplanetary relations are much more significant. And as we will see, there is also the possibility of planets returning to inter- or multiplanetarity in novel ways at later stages in their development.

The multiplanetary

During the formative phases of a planetary system, the Family of participating planets are in constant interaction not just with each other but also with the interplanetary and circumstellar Families. These exchanges continue for some time after the formation of spherical planets, as was the case for the Earth during the Hadean eon from 4.5 to 4 billion years ago, when the space between the planets of our solar system was thick with dust and planetesimals, planetary orbits were therefore unstable, other entities frequently encountered and collisions were common (such as the hypothesized one between the early Earth and a Mars-sized planet which it is thought formed the Moon and gave the Earth an enlarged iron core). As planets and planetoids impact, merge and part, pull each other around, and exchange bulk elements via meteors, it might be said, to adapt Bruno Latour's formulation, that they are working out "how many are we and how shall we live together".[35]

Then comes the long 'middle period' in which planets more-or-less turn their backs on each other.[36] But for all our wariness about Terran chauvinism, the single case of the Earth stands as evidence that some late-stage planets have the potential to re-convene multiplanetary relationships. If the advent of human space flight demonstrates the feasibility of transferring complex matter or pure information between astronomical bodies, it also raises the possibility of planets finding other methods of significantly affecting each other's developmental trajectories in informationally rich ways.

The Earth certainly seems to be playing a key role in our own solar system overcoming its mid-period regime of planetary isolation, and the development of a whole new suite of interplanetary interactions. However, merely ascribing this to human scientific and technological achievements alone would be to prematurely narrow the idea of what planets can possibly do. By contrast, a deep-time approach to the question, that asks about how evolving conditions on the early Earth's surface would later enable the development of powered space flight, can help us discern more general likely patterns in the late-planetary acquisition of interplanetary capabilities.

We might first consider the growing exchange of information between planets. When Earth animals colonised the land around 300 million years ago, the move from the ocean to an atmosphere increased visual ranges some hundredfold – which in turn opened up novel evolutionary opportunities and further pressure to develop long-distance vision.[37] Animals became able to not just detect the light of sun and moon, but to see astronomical entities, which enabled stellar navigation.[38] If bird migrations might be considered one apogee of long-distance celestial wayfinding, we should also consider the remarkable achievements of sun- and star-guided human navigators – especially Pacific peoples, whose ventures into the open ocean, including intentional one-way expeditions, began some 4,000 years ago.[39]

The shift to life on land, in a clear atmosphere and on a solid surface that changed its configuration much more slowly than oceanic life, not only enabled animals to see long distances but also gave them the opportunity and stimulus to learn how to build a mental picture of enduring spatial arrangements, and to shift from habit and immediate reaction to planning and hypothetical speculation.[40] The colonisation of land by animals thus might have been a necessary stage for Earth biology not only just to *see* other astronomical bodies and to gather information from them, but also to build a picture of how these bodies are arranged in space, to manipulate matter into new forms and constellations, and to form long-term plans involving a wide range of organic and inorganic materials.

When it comes to moving matter between planets, it is surely not insignificant that Earth is the only astronomical body in our solar system on which fire is known to occur naturally, and that the capture of fire by a single biological genus around a million years ago has greatly augmented available energy.[41] The later intensification and heightened control of fire in purpose-built chambers enabled the production of a range of strong, ductile, heat resistant and relatively light-weight materials.[42] But perhaps the most crucial step towards escaping the Earth's gravitational field was the concoction of ultra-high-speed combustion just over a thousand years ago – arguably the first entirely new form of fire since the first appearance of flame on our planet some 400 million years ago. The outcome of intensive experimentation with the metamorphic power of high heat, *huo yao* or gunpowder, when packed into a robust container, allows an explosive release of energy. Gunpowder-propelled projectiles played a significant role in the calculation of trajectories and in the very idea of the targeted movement of objects, while the quest for less destructive, non-weaponized uses of split-second combustion was an important impetus for the development of heat engines during a later phase of thermo-industrial innovation.[43] After the detour of the steam engine, explosive propulsion came of age with the internal combustion engine and jet engine, and finally, the rocket, which with its ultra-rapid oxidization is capable of generating enough thrust to escape Earth's gravitational pull.[44]

While it is the surge in productive capacity together with the global interconnecting of infrastructures driven by industrial capitalism that is usually credited with the inauguration of a planet-wide 'technosphere', we should not underestimate the enabling role of antecedent and differently centred developments. As was the case with thinking about possible earlier biospheres overwritten by later ones, we might also consider the possibility that pyrotechnical and related industrial innovations in what is misleading considered 'premodern' China – or elsewhere for that matter – could have generated alternative capabilities and rationales for exiting Earth. So too might we speculate about our planet or other planets engendering pathways to multiplanetary that did not pass through explosive propulsion and its supportive thermo-industrial infrastructures.

The ‘technological civilization’ imagined by much SETI science and science fiction – a civilization capable of sending messages across space, building megastructures detectable from great distances, or moving organic beings and technological devices to other planets – may be just one of many ways that individuated, self-othering planets can become intertwined. Science fiction has provided many imaginative ideas about how that might happen, including huge spider-like vegetables crawling on webs strewn between tidally locked worlds.[45] Nevertheless, planetary gravity wells are deep, and the energy required to escape them is significant. If conditions upon or within a planet itself might be best for generating complex matter,[46] conditions up in the planetary rings and moons may turn out to better for enabling assemblages of complex matter to achieve orbital escape velocity.

But one thing that planets are likely to need to become multiplanetary again is *a lot of time*. Planets like ours that orbit G-type, main-sequence stars (stars at thermal equilibrium that generate energy by ‘burning’ hydrogen into helium) last perhaps ten billion years before their star evolves into a red giant and destroys them – meaning that the Earth is already entering the second half of its life. However, red dwarf stars can stay on the main sequence for an estimated six to twelve trillion years, giving their planetary systems a lifetime that is some thousand times longer than the projected lifetime of the Earth.[47] If it is hard to imagine what a planet or planetary system could do given that much time, it is also a helpful prompt to expand and diversify our own multiplanetarity visions.

Conclusion: ‘*Without hope of return*’

It’s worth remembering that when Donna Haraway first affirmed the necessity of situating knowledge and avowing the partiality and particularity of all truth claims, her rationale was that this facilitated better collective accounts of reality.[48] But as with Yunkaporta’s vision of an active relationship between his people’s ‘living country’ and celestial bodies, there is little to indicate that Haraway intended to draw boundaries around the location of truth-claiming or to restrict knowing or doing to a specific scale. Planets, galaxies, the cosmos, Yunkaporte seems to be reminding us, are also places, if we chose to see them that way. So while contemporary more-than-western astronomical sciences might be construed as advancing universal or totalising accounts of planetary behaviour, we prefer to read them as affirming the unique and specific trajectories that each planet follows. Or as Likavčan puts it: ‘A planet becomes a planet by virtue of undertaking a certain evolutionary pathway.’[49]

For us, planetary science helps embellish Spivak’s notion of planetarity by detailing differential capacities that include but are also irreducible to humans or any fellow inhabitants of our planet or of other astronomical bodies. And in this regard, it's also worth returning to Derrida's more general reflections on the self-undoing of identity. When he spoke of "adventuring outside oneself toward the unforeseeably other," Derrida was referring not simply to the predicament of being human, but to a structural logic of self-othering '[*w*]*ithout hope of return'* that characterizes any sufficiently complex being or entity.[50] To persist or survive, as he later elaborated, inevitably involves change, including the possibility of annihilation or the risk of becoming unrecognisably different.[51]

Planets, in this way, fit comfortably into the category of entities which are propelled by originary complications and external stimuli to traverse pathways with no return, even after they have settled into relatively predicable orbits. As we sought to show, a planet reaching a stage at which it gives rise to sub-entities or offshoots capable of establishing novel multiplanetary connections is at once undergoing a 'revolutionary' departure and taking one more step in a succession of symmetry-breaking bifurcations. And, as we might further extrapolate from Derrida, any being or life-form that leaves its home planet in the interests of ensuring survival – or in pursuit of some kind of value or utility, most probably for a subset of the species – submits itself to the paradox that in becoming ex-orbitant it also breaks with own self-sameness.

For us, then, the point of exploring notions of planetarity is less about choosing between earthbound and extraterrestrial futures than it is about learning how best to navigate one more threshold in the becoming-other of our planet. Every such transition has been and will be difficult and wrenching – and there is much that we still don't know or have yet to ask about how our planet has negotiated its own 'revolutionary' processes of self-differentiation. A more sustained empirical and ontological thematization of the historical self-othering of the Earth might also help us to appreciate the achievements, both 'gains' or 'losses', of other astronomical bodies, and in this sense deepen the grounds upon which we decide what matter and information ought to be brought into interplanetary exchange.

But the fraught and crude way that many human actors are currently approaching the domestic intraplanetary bifurcation shorthanded as the Anthropocene suggests that some of us still have a way to go before we are ready to establish meaningful multiplanetary relationships - or even generative exchanges with peoples who already cherish their interaction with other cosmic entities. And in this sense, the question of 'what planets do' at once propels social thought out of the orbit of the Earth and brings us spiralling back to the ethico-political issues of shared but differentiated earthbound dwelling that engross so many human geographers and fellow critical thinkers.

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[3] N. Clark and B. Szerszynski, *Planetary Social Thought: The Anthropocene Challenge to the Social Sciences* (Cambridge, Polity, 2021), pp. 35-38.

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[5] T. Yunkaporta, *Sand Talk: How Indigenous Thinking Can Save the World* (Melbourne: Text Publishing, 2019), p 40.

[6] A. Bobbette, The Pulse of the Earth: Political Geology in Java (Durham NC.: Duke University Press, 2023).

[7] N. Clark and B. Szerszynski, *Planetary Social Thought,* pp. 23-32.

[8] G. Deleuze, *Difference and Repetition* (London, Athlone Press, 1994), pp. 28-69.

[9] G. Simondon, 'The genesis of the individual', in J. Crary and S. Kwinter (eds), *Zone 6: Incorporations* (New York, Urzone), pp. 300-1.

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[12] G.C. Spivak, 'Planetarity', p. 73.

[13] For a comprehensive overview see A. Franklin (ed) *The Routledge International Handbook of More-than-Human Studies* (London: Routledge, 2024)

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[15] L. Likavčan. 'Another earth: An astronomical concept of the planet for the environmental humanities', *Distinktion: Journal of Social Theory*, 25:1 (2024), 17-36, p 18.

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[19] S.J. Dick, *Classifying the Cosmos*, p. xxxv.

[20] L. Messeri, *Placing Outer Space.*

[21] G.C. Spivak, 'Planetarity', p. 78; A. Morbidelli and S.N. Raymond, 'Challenges in planet formation', *Journal of Geophysical Research: Planets* 121 (2016), pp. 1962-80.

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[23] S.J. Dick, *Classifying the Cosmos*, pp. xliv-xlv.

[24] G. Deleuze, *The Logic of Sense* (New York, Columbia University Press, 1990), p. 109.

[25] S.J. Dick, *Classifying the Cosmos*, pp. xxxiv-v.

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