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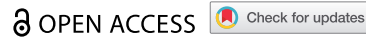


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RESEARCH ARTICLE



Making Mars: The Emergence of a Resources-Territory Areopolitics

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ABSTRACT

Human activities are territorialising and commodifying Mars. Areopolitically reexploring the planet is a pressing necessity as outer space actors have increasingly been operating there for several decades, intensifying thus the interaction. This paper argues that territory and resources are being made on the basis of a novel theoretical framework in the involved sub-fields of geography that it formalises, utilises, and advances: the resources-state-territory nexus and, more specifically, the resources-territory sub-nexus. The unprecedented application of a nexus thinking on areopolitics allows to analyse both sectors simultaneously. This study is informed by the Foucauldian apparatus and is grounded in the conceptual breakthroughs of object-oriented ontology. The discourses and materials, actually conceivable as objects, of the Martian endeavour are that way critically investigated to uncover the dynamics of the nexus. It results that areometrics not only creates territory but influences the creation of resources and, parallelly, that commodity frontiers not only create resources but influence the creation of territory. This interdependence is the core of the sub-nexus. Besides, the exclusive robotic mediation of the relationship with the Red Planet calls for an examination of its implications. Pointing out probe-power further brings to light the bonds between the territorial sub-elements, terrain and land, and resources through the stress it exercises on these interconnections. It also strengthens territory by creating a bridge between its constitutive sub-elements. Hence, the terrain- and land-resources bonds prove to be more substantial than the main sub-nexus, which renders the questions of territory and resources even more inseparable.

Introduction

The director of the Center for Space Resources at the Colorado School of Mines acknowledged that the space mining industry has advanced to the point where several minor and major businesses are tackling various parts of the 'space resources value chain' (David 2023). Many companies have projected to mine in outer space hitherto without success. However, this can quickly

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change, as suggested by the ambition of some start-ups, like AstroForge. The company has recently raised US\$13 million and already booked an experimental flight with SpaceX, aiming by the same token at becoming the ‘first-ever viable asteroid mining company’ (Wall 2022). This really seems to be the beginning of the *Era of commercial space mining* in which the private and also the public sector is intimately involved, the latter being a catalyst of the former (Gilbert and Bazilian 2020). Nevertheless, this ‘emerging public-private hegemony’ is not uncontested (Sammler and Lynch 2021, 706). Spaceport America’s case is the latest representation of such hegemonic capitalist expansion in off-world activities. Against the ensuing visions and practices, alternative cultural imaginaries, technological systems, and political economic models are constructed by autonomous organisations. Competing anticipatory futures are being negotiated there. In this process, the potential is also given to radically different perspectives envisioned by those counter-hegemony who aspire to make outer space an open space.

Regarding national agencies, missions scheduled for the coming years are in no way less bold, with the National Aeronautics and Space Administration (NASA) working, for instance, on the Artemis programme and the return of humans to the Moon. Eventually, it will make it a springboard for going to Mars. Goals are set at a higher level each time: the Earth’s orbit or the Moon now seem to be evident destinations, and further places in the solar system are increasingly targeted as the next steps. More specifically on Mars, it has a history of decades of exploration involving tens of spacecrafts from every major space-capable country. Nine active missions are currently reckoned, with five others to come, which makes it the most explored place in outer space at the time of writing (The Planetary Society 2023). In the US, this Martian interest is supported by 64% of Americans, who agree or strongly agree that humans should be sent to Mars (Phillips & Company 2016).

Irrespective of *Old Space* or *New Space*, all these efforts have a consequence in common: the unprecedented extension of human presence in new places. The initiatives stemming from the private, public, or both partnered sectors make the interest in resources and exploration a spearhead of humans’ action in outer space. As a matter of fact, resources are seen to be an ‘enabler of space exploration’ (David 2023). Some, like Elon Musk, are even thinking about colonising the planet to preserve humanity (Solon 2018). These utopiae that see human beings as an extra-planetary species are flourishing in Silicon Valley (Tutton 2021). They are characterised by an anthropocentric pessimism and a sociotechnical optimism displayed by collectively performed sociotechnical imaginaries. Again, these initiatives and investments are not exempt from contestation because they escape global challenges humans are confronted with on Earth. These problems are often symptomatic of capitalism, over which these entrepreneurs are thriving and present apparent solutions. Since the

Space Race, the conquering dimension of the outer space endeavour has manifested somewhat in a more discrete way at present, but it still feeds the idea of a conquest of the ‘final frontier’. Thus, the questions of territory and resources are much closer to each other than they might appear. Whether due to the commercial incentive of the private sector or the explorative desire of states, as well as the symbiosis of those, asteroids, satellites, and planets are being transformed into territories and resources. This is precisely when politics emerges and makes the topic unequivocally geo-, astro-, or rather – as it is here argued – areo-political (the prefix *areo* refers to the planet Mars). Areopolitics is the conjunction of politics and areography, the exercise of power over the Martian space.

Human presence on Mars is dreamt of but still far on the horizon. Even if the Apollo missions have proven that stepping on an inhospitable celestial body was at reach, the distance with all its operational constraints has been barring the way to the Red Planet for living beings. Yet, an armada of probing machines are working there all day long. This proxy presence is not without intriguing. Does it mean that humans have forsaken that place? Not really. There is a tremendous number of people and effort put in the execution of every mission, materialised ‘just’ in one or two robots of few metres and kilogrammes, which is just one out of many examples that invite to ontologically rethink the stance and power of objects.

Recent advances in geopolitical theory have brought a new and more thorough comprehension of resources and territory. The notion of *commodity frontiers* (Moore 2000) has revisited resources as a socio-ecologically and economically defined process, as opposed to a mere inert and neutral raw material of the production chain. The canonical conceptualisation of territory as a *political technology* (Elden 2010), updated with a three-dimensional vision (Bridge 2013; Elden 2013), has also ushered in a volumetric turn (Jackman and Squire 2021). Combining it with the material turn (Bakker and Bridge 2006; Harman 2002; Latour 2007), although without disregarding discourse, certainly offers a fertile intellectual foundation. Hence, it is here proposed to examine the areopolitical apparatus, that is, the Martian spatial *dispositif* (Foucault 1980; Lussault 2007). This is done by harnessing the specific sectors – which are territory and resources – within a formalised nexus framework recently suggested by scholars (Bridge 2014; Huber 2019). This relatively new approach is also spreading in other sub-disciplines of geography (e.g., Allan, Keulertz, and Woertz 2015). Twisting a bit the apparatus, a speculative realist insight is given by adopting an *object-oriented ontology* (OOO) (Harman 2018) to reveal the power of Martian probes. This work is positioned in the continuity of the critical school of geopolitics (Ó Tuathail 1996). Following a postmodern cultural turn that has opened the door for an ‘extra-terrestrial human geography’ (Cosgrove 2008, 47) and even a *more-than-*

terran (Olson 2023) shift, it aims at decrypting the geopolitical implications of outer space actors present on and around Mars. This paper is a specific contribution to areography (Lowell 1902; Sheehan 2015), astropolitics (Havercroft and Duvall 2009), and especially the very nascent areopolitics.

Approaching Mars with the Resources-Territory (RT) sub-nexus emerges as fruitful. Delving into the nature of territory and resources permits to highlight the underlying dynamics that feed them. It turns out that on the one hand, areometrics is a territory-maker, meaning that the diverse areometrical operations are constitutive of a political technology equating to the Martian territorialisation; and on the other hand, the commodity frontier is a resource-maker, meaning that the expansion of the production prospect into Mars makes its commodification possible. Furthermore, these streams connect both sectors whereby territory is also influenced by commodity frontiers and resources by areometrics. This is how the RT sub-nexus is formed. When realising that Mars exploration has remained unhumanned until now, it questions the consequence of an exclusive robotic presence on the Red Planet. In fact, areopolitics embeds a more-than-human dimension in which spacecrafts must be seen as a source of power, that is, probe-power. This concept stresses the substantial interconnections that exist between the sub-elements of territory – which are terrain and land – with resources and also themselves. In the former case, it accentuates the bonds between terrain, land, and resources – and thus between territory as in the outright union of its constituents and resources. In the latter case, it establishes a bridge that strengthens territory by animating the relationship between its constitutive parts through the infrastructures of power. These bonds bring another degree of complexity that is crucial in the holistic understanding of the overarching sub-nexus. Taken together, the primary dynamics of the sub-nexus and the more subtle bonds make the Martian territorialisation and commodification intelligible in an inseparable fashion. This is how the RT sub-nexus is comprehended (Figure 8).

It is here asked how Mars' territory and resources are being made by outer space actors.

In the section that follows, the literature is reviewed. In the second section, Martian territorialisation and commodification are analysed through the resources-territory sub-nexus. The areometrical grasp allowing the emergence of territory and commodity frontiers as a resource extraction dynamic are substantiated. In the third section, an OOO approach to the RT sub-nexus is proposed by exploring how probe-power stresses the bonds between terrain, land, and resources. The dissection of the potential of probe-power and the subsequent stress on the political materiality of terrain-resources and the property feature

of land-resources bonds are explained. In the final section, some points implied by this study are discussed and concluding remarks are offered.

'Spaces of Outer Space', Territorial Rationalities, Frontiering Resources, and the Power of Objects

An Unavoidable Field

Beery (2016) invited geographers to 'reject anxieties [...] about engaging with outer space' (p. 68). This invitation is even more relevant for several reasons: outer space technologies are becoming increasingly present in daily lives (Johnson 2016); the sector is growing and diversifying at an unprecedented rhythm, with private actors viewed as launching a *new space race* (Grady 2017); progress in science and technology is enabling a better understanding of the universe (e.g., Abbott et al. 2016) and prospect for improved interstellar propulsion systems (Cassibry et al. 2015), which indicates that human space exploration of adjacent star systems may become a reality based on the current state of knowledge in the next fifty to one hundred years (Bignami and Sommariva 2013). As argued by Dunnett et al. (2019), the expanding prominence of outer space in culture and politics, as well as the necessity to contextualise this evolution, 'should be of pressing concern' within contemporary human geography; after pointing out the vagueness of the term 'space' to comprehend something as immense and diverse as the cosmos, they introduce a plural and more nuanced approach of 'spaces of outer space' (p. 315). The recent *more-than-terran* refielding of social sciences by Olson (2023) is only rejoicing. This paper thus answers these calls and goes further on this rising path within human and, more precisely, political geography.

Hegemonic astrocultures are based on territorial expansionist ideologies and land-centred imaginations (Geppert 2012). The conquest of the 'final frontier' has an eminent imperialist dimension, calling into question the true nature of an offensive realism going far beyond strategic balancing and power competition (Havercroft and Duvall 2009). Therefore, the problem is that the frontierist and expansionist ideology is embedded in well-established geo-centric astrocultures, along with a territorial gaze, following which Westphalian logics are cast in outer space (Billé 2020). This is certainly not unrelated to the fact that geographers have mainly studied outer space through critical geopolitics (Ó Tuathail 1996) or, more newly, critical astropolitics (Klinger 2021a). In light of the current intensification of space activities, projects, and the subsequent danger of reworking outer space into the 'next frontier for colonization, resource extraction, and militarization' (Klinger 2021a, 661), the critical school of astropolitics has endeavoured during the past years to contest traditional geopolitical assumptions over states' visions and policies on outer space and also prevalent territorial understandings. Issues such as Earth power relations incorporated in spaceflight industries

(Beery 2016; Collis 2009; Warf 2007); in space-promoting organisations (Dunnett 2017; MacDonald 2007); the interconnectedness of national identities and military-industrial complexes in outer space demonstrated by the importance of national space programmes (Sage 2014) and space cultures (Dunnett 2012); and the stories of discovery and adventure explaining how they shaped a sense of frontier expansionism helped by earth-orbital imaging, rocketry, and planetary visualisation (MacDonald 2015; Sage 2014) have been addressed. More generally, popular geopolitics (MacDonald 2008; Sage 2008), environmental geopolitics (Klinger 2021b), geopolitics of social relations (Sammler and Lynch 2021), historical geopolitics (Saperstein 2021), imaginary geopolitics (Lane 2011; Maclaren 2021; Marino 2023; Sage 2008), postcolonial geopolitics (Dittmer 2007; Dunnett 2021; Smiles 2023; Treviño 2023) of outer space have to this day been discussed. Scholars' work in legal geography is also to be noted (Collis 2016, 2017; Collis and Graham 2009; Marino and Cheney 2023). Notwithstanding these contributions, engagement with the astropolitics of territory and resources appears nonexistent. The closest approach to Mars in this perspective so far was made by Puente-Lozano and Herring-Bazo (2023), with a focus on territory and imagination.

About Territory

The theory of Elden is celebrated amongst others as a 'canon of social science literature' by the astropolitical scholarship (Klinger 2021a, 662). His explanation of territory as a processual '*political technology*', a bundle of 'techniques for measuring land and controlling terrain', is a landmark contribution (Elden 2010, 811, emphasis added). This finding has been supplemented by the consideration of a third spatial dimension: territory is a volume (Elden 2013). The 'comprehending and compelling, organising and ordering' effect of calculative and metrical actions – consisting of 'bio-metrics' and here especially '*geo-metrics*' – can be understood as constitutive of the process of territory-making, that is, territorialisation (Elden 2013, 49, emphasis added). The *politics of verticality* (Weizman 2002) enables the generation of new forms of power in subterranean and supraterranean realms because they are exercised downward and upward (Graham 2004; Williams 2013). The physical territorialisation of vertical space and the power over the conceptualisation of spaces may either or both be made possible by their control (Adey 2013). Indeed, this is supported by an ongoing discussion about the territorialisation of new geopolitical battlegrounds, such as outer space, where territory's three-dimensional nature is expanding (Billé 2020). States and private actors are increasingly pursuing material and discursive practices that target space as a whole territorial volume (Wang 2021).

It is possible to imagine that Earth's volumes are prolonged into outer space in consistency with the gradual *logic of political territoriality* (Vollaard

2009), even if the extension of territorial and sovereign control must not be conflated (Steinberg, Tasch, and Gerhardt 2015). Hence, regardless of how far claims to territorial sovereignty truly persist, ventures into volumetric spheres that may lead to specific rights such as use, exploitation, or property should be seen as the very first step towards territorialising outer space; in such territorialisation, a ‘gradual arrogation of spaces previously found beyond the realm of human existence and colonizing possibilities’ is being expressed (Billé 2020, 8). Nowadays, asserting sovereignty thus involves material and discursive practices that are fluid, complex, entangled, and simultaneously spreading in all directions (Mason and Khawlie 2016). The increasing fluidity of corporate nationality through the utilisation of ‘flags of convenience’ is an example (Reynolds and Merges 1997, 279). In that respect, disputes over deep-sea and subsurface mineral resources are very instructive (Squire and Dodds 2020).

Moreover, territory must be distinguished from *terrain* and *land*. As a matter of fact, it is ‘something that is both of these, and more than these’ (Elden 2010, 804). The former is understood as a political-strategic sub-element related to questions of power, geology, and the military. The latter is a political-economic one related to questions of property and resources. Likewise, it is noteworthy to specify that territory ‘should not be confused with the more generic notion of terra – “the terrestrial” [...] – which provides a variable, technologically conditioned, and relational “raw material” of territorialization as a specific political process’ (Jessop 2015, 35 (as quoted in Elden 2017)); or in Elden’s (2017) words, that ‘territory is not the same as *terra* or the terrestrial’ (p. 207). Focusing on the word *terra* to avoid confusion with the word *terrestrial*, which can be a synonym for Earth, these theorisations of territory can be applied to Mars.

About Resources

Connecting the question of territory with resources appears indispensable. First and foremost, the materiality of natural resources is a political matter (Bakker and Bridge 2006). They are politicised by being ‘constitutive of and constituted within arrangements of substances, technologies, discourses, and the practices deployed by different kinds of actors’ (Richardson and Weszkalnys 2014, 16). Similarly, significant aspects of the state are naturalised, which makes the very ‘peculiarity of “state resources”’ (Bridge 2014, 119). Some authors have even developed the idea of a *state nature* (Whitehead, Jones, and Jones 2007), in which state territorialisation is identified as an important historical tendency between nature and collective life, that is, making the former a subject of state governance. When nature takes ‘the form of valuable resources, [it] has a crucial role in shaping the geopolitical existence of many modern states’ (Whitehead, Jones, and Jones 2007, 6), generating

what is sometimes referred to as *resource races* (Kaplan 2012; Klare 2012) or even *resource wars* (Klare 2001; Le Billon 2004) with bordering dynamics thereof. After all, *state territory* (Walker 1993) is one of the most effective territorialisations of space and understanding of them. One precedent can be found in Canada's shifting forms of state rationality at the end of the 19th century (Braun 2000). Whilst geology made a vertical breakthrough for the state territory, this volume accelerated the social production of an intelligible nature. Capitalisation and commodification resulted amidst an assemblage in which nature but also the state and its determinants had been being reconstituted. Importantly, 'post-sovereign' (Bridge 2014, 123) forms of resources challenge again the relationship between state and territory regarding the access, control, and authority on resources (Emel, Huber, and Makene 2011; Yeh 2012), giving the way to a 'variegated sovereignty' (Ong 2006, 7).

Resources are materially and socially defined by territorialisation in 'dialectic relationships with institutions and practices' (Le Billon 2004, 2). In that respect, different types of territorialisation have been identified. The territorial production by *resource frontiers* with examples such as the Arctic (Dodds 2010), exclusive economic zones (Steinberg 2011), and outer space (Damjanov 2022) is one of them. Historical developments, far from endorsing outer space as a global common, suggest a maturing *commodity frontier* (Moore 2000), where outputs are becoming excludable and subtractable (Ostrom, Gardner, and Walker 1994). What Moore (2000) theorised designates both a socio-spatial movement and a specific geographical place in a simultaneous fashion, accompanied by a typical 'forward movement of the (capitalist) system' creating new social, ecological, and economic flows and expanding into new spaces (p. 412). The view of resources, territory, and the global production network as being coproduced contends that idea (Bridge 2008). Frontiers and territorialisation are thought of as co-constitutive, where the formers are seen as momenta of spatial control that challenge existing institutional arrangements in a fluctuating manner and the latter as establishing authority; such 'dynamics are part and parcel of resource commodification and emerging property regimes' (Rasmussen and Lund 2018, 389–390). There are several kinds of 'governmental techniques for claiming space on the frontier: political authority; boundaries and cartographies; law and bureaucracy; and enforcement and violence' (Rasmussen and Lund 2018, 390). Resource management science and the interconnection with geopolitics, like the US water resource planning during the Cold War (Sneddon and Fox 2011), is another modality of territorialisation that has been inquired. It is worthy of note to remind that 'extraction is a territorializing project' as demonstrated in the Latin American extractivist context (Bebbington and Bury 2013, 18). This subsoil dimension is akin to space mining and does not preclude Mars.

In a salient way, controversies, vagueness, and uncertainty in current space law make the development of clear property rights and consequent

restructuring of the international legal framework for outer space necessary in order to *inter alia* carry out space-based mining (Leib 2015). Volume is a ‘spatial form of property’, where ‘mining is [also] about [...] the exercise of power [which] involves technologies of calculation, visualization and manipulation around [it]’ according to Bridge (2013, 56). As a matter of fact, access and property go side by side with power and authority through the ‘recursive constitution’ of institutional authority and property rights, which offers an enlightening insight into state formation (Sikor and Lund 2009, 2). In any case, ‘appropriation of land can exist outside the sphere of sovereignty, but its survival is dependent upon endorsement from a sovereign entity’ as emphasised by Pop (2000, 281). The role of property – which is a form of territorial enclosure – on resource extraction thus needs to be investigated more deeply (Huber 2019).

All in all, the geography of resources literature is suffering from a scarcity of formal engagement with state, nationhood, territory, and sovereignty theories, according to scholars (Bridge 2014; Huber 2019). Yet, the question of resources is inextricably linked to territory. Hence, explicitly engaging the Resources-State-Territory (RST) nexus hinted by Bridge and Huber, emerges as a fertile effort.

About the Power of Objects

Starting to explore the power of objects with the Heideggerian philosophy is informative. Technology cannot simply be understood as a collection of tools or machines but as a way of revealing and transforming the world. They exist beyond humans and, as such, ‘so long as we represent technology as an instrument, we remain held fast in the will to master it’ (Heidegger 1977, 32). This more-than-human dimension of reality is well recounted by Harman (2002), who writes: ‘Forget for a moment everything that you think you know about the differences between people and utensils, [...] both hammers and Dasein are involved in the sheer execution of their respective realities; however different these realities may be from one another, both unleash their forces in the world’ (p. 37). So OOO was born in the 1990s as an attempt to render unto objects the agency that is objects’, outside the human (subject) and non-human (object) dichotomy, and in which they are withdrawn from direct access (Harman 2018).

Objects themselves can be ‘wellsprings’ of power; this is what is called ‘*tool-power*’ by Meehan (2014, 216, emphasis added). This stands for their autonomy and irreducibility, forcefulness, and resulting power. Indeed, science and technology sciences and OOO emphasise the idea that objects, that is, all kinds of tools, beings, and things, serve as pivots for political inquiry (Harman 2002; Heidegger 1977; Winner 1977): they are ‘force-full’ (Shaw 2012, 621).

Delving into the implications of this ontological conceptualisation is a means to further understand the *objective* reality of human artefacts on Mars and its consequences on the planet's making.

Martian Territorialisation and Commodification Legible through the Resources-Territory Sub-Nexus

The RT sub-nexus appears as the epitome for the inclusion of territory and resources in understanding Mars making. Whilst the areometrical operations taking place on and around the planet irremediably transform this place into a territory via a bundle of political technology (Elden 2013), they also allow the resources to be made visible and intelligible. Ongoing mission programmes for Mars are unequivocally putting a significant emphasis on the question of resources, especially through mining. The prospect for resource extraction and subsequent production is extending commodity frontiers in remote places of the outer space realm without sparing Mars, with all the tricky logics involving the combined agencies of empire, capital, and science (Moore 2000). This extension transforms the planet into a resource to be exploited. The frontiers, in turn, bring territorial effects by means of a toggling process (Rasmussen and Lund 2018).

The Areometrical Grasp Allowing the Emergence of Territory

Metrical and calculative operations – or what is here called areometrics – have greatly maintained human relations with Mars. This is obviously to be understood in the geopolitical sense, albeit it consecrates a Martian variant of geometrics attending to the same territorial logics. From a surface perspective, cartography emerges as an art of performing territorialisation par excellence (see Crampton 2011). Critical cartographers have insightfully pointed out the Foucauldian conjunction of knowledge and power in geography (Crampton and Krygier 2005; Harley 1989). Starting with cartography sounds appropriate, as it is perhaps one of the most ancient and powerful way of reproducing data deriving from such operations. Indeed, cartographical works have notably played an influential role in outer space exploration (Statella 2015). The Martian maps of Schiaparelli and Lowell in the late 19th century had, for instance, been influential in convincing the scientific community respectively of the existence of canals and its proof for the presence of intelligent life until the next century (Lane 2006). In fact, Mars mapping started as early as the 18th century with the drawings of Herschel (Stooke 2012). Once only limited to coarse telescopic observation prone to inaccuracy, areometrics has faced a dramatic turn with the progress of technology and the launch of probes, also bringing the political matter to an incomparable level. Since the very first failed Soviet attempt with *Mars 1960A* (in 1960) until the actual successful

arrival of the American *Mariner IV* in 1964 at the Red Planet, every mission has carried a camera in order to take the closest photograph ever. Ironically, the American premiere was based on an anachronic map made by the Aeronautical and Chart Information Center (ACIC) of the US Air Force featuring the dismissed Schiaparellian ‘canals’, which is further evidence of the power of maps. Eventually, the successive Mariner missions constituted a compilation of isolated clichés until the landmark global view enabled by *Mariner 9* in 1972. The special attention accorded to the release of the first images from *Mariner IV* amongst all the scientific data gathered at the Red Planet was palpable, as witnessed by the opening words of Pickering (1965) during the dedicated conference: ‘before going into the conference proper, I am sure that all of you would like to know where we stand on the photography’ (p. 2). As a matter of fact, NASA acknowledged and responded to the public thrill at it all, that is, the call for a graphic update (Figure 1). Whilst purely photographic in 1965, it paved the way for a full-fledged cartographical product, which was elaborated in 1972 following the craze for this kind of material. At this point, Masurky (1972), a geological surveyor, was leading the conference team and spoke in the following terms: ‘this is our first map of Mars. [...] We will be expecting to be publishing this shortly’ (p. 15) (Figure 2 or p. 15b). No other data was afforded such a special treatment. NASA

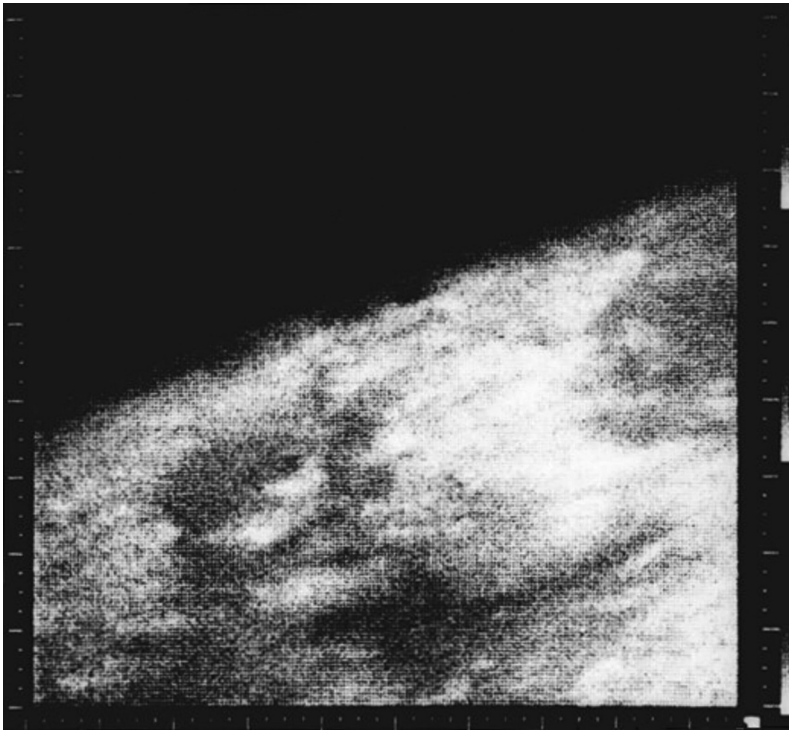


Figure 1. First close-up image of Mars taken from *Mariner IV* (NASA 1965). Public domain.

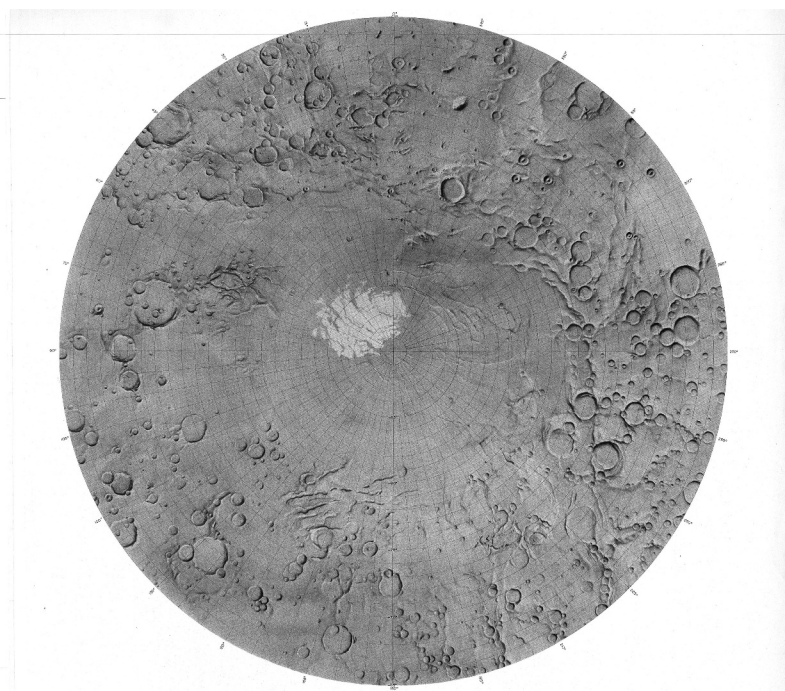


Figure 2. First map of Mars showing the South Polar region (USGS and NASA/JPL-Caltech 1972, detail). Public domain.

undoubtedly wanted a broad audience to access this map, showing therefore a discursive tendency where Mars was prominently a subject of cartographical interest. This argument can be supported by the Space Race context, in which this and the next maps certainly served as a visually striking display of knowledge and power, demonstrating American supremacy. The completion of the Mariner 9 mission unsurprisingly led to the release of the unprecedentedly accurate images-based map of Mars by the United States Geological Survey (USGS) (USGS 1976). This trend is representative of how all governmental actors have been conducting their research on Mars. Hence, this was only the beginning. Far from settling for the USGS production, later missions have been continuing to survey the planet with every time higher resolution and more sophisticated imaging instruments (Coles, Tanaka, and Christensen 2019), leading thereafter to the publication of the collected cartographical contents (Table 1). For this reason, there is now a considerable number of Martian maps encompassing images, topography, geology, mineralogy, hydrology in GIS and even 3D formats (see USGS 2023), making every corner of this place more measured and calculated than ever. Nevertheless, as the quantity of similar maps unfetteredly grows, the scientific goal proportionally appears elusive.

Table 1. Chronology of Mars orbital and flyby missions' image mapping.

Spacecraft	Launching agency	Covered scale	Instrument ^a	Notable map
Mariner IV (1964-1967)	NASA (US)	Local	TV camera	ACIC (1967)
Mariner VI and VII (1969)	NASA (US)	Local	2 TV cameras	NASA (Date unknown)
Mars 2 and 3 (1971)	(USSR)	Local?	2 cameras	(Unknown) ^d
Mariner 9 (1971-1972)	NASA (US)	Global	Imaging system (camera)	USGS (1976)
Mars 4 and 5 (1973-1974)	(USSR)	Local?	2 TV cameras and OMS scanner	(Unknown) ^d
Viking 1 and 2 Orbiters (1975-1980/1978)	NASA (US)	Global and local	Visual Image Subsystem (VIS) (2 vidicon cameras)	USGS (1985)
Mars Global Surveyor (MGS) (1996-2006)	NASA (US)	Global	Mars Orbiter Laser Altimeter (MOLA)	USGS (2002)
			Thermal Emission Spectrometer (TES)	TES Team (2020)
		Global and local	Mars Orbiter Camera (MOC)	MSSS (2002)
Mars Odyssey (since 2001)	NASA (US)	Global and local	Thermal Emission Imaging System (THEMIS)	THEMIS Science Team (2019)
Mars Express (since 2003)	ESA (EU)	Global and local	High-Resolution Stereo Camera (HRSC)	Technische Universität Berlin (2005) ^e
			Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA)	Ody et al. (2012)
Mars Reconnaissance Orbiter (since 2005)	NASA (US)	Global	MARs Color Imager (MARCI)	Wang, Battalio, and Huber (2021)
		Global and local	Context Camera (CTX)	The Bruce Murray Laboratory for Planetary Visualization (2023)
			Compact Reconnaissance Imaging Spectrometer for Mars (CRISM)	John Hopkins University (2022)
		Local	High Resolution Imaging Science Experiment (HiRISE)	LPL (2023)
			Mars Colour Camera (MCC)	Jain et al. (2015, 1–111 and 119–122) ^f
ExoMars Trace Gas Orbiter (since 2016)	ESA and Roscosmos (EU and Russia)	Local	Thermal Infrared Imaging Spectrometer (TIS)	
			Colour and Stereo Surface Imaging System (CaSSIS)	ESA (2024)
Tianwen-1 Orbiter (since 2020)	CNSA (China)	Global	Moderate Resolution Imaging Camera (MoRIC) ^b	CNSA and CAS (2023)
		Global and local	Mars Mineralogical Spectrometer (MMS) ^b	
		Local	High Resolution Imaging Camera (HiRIC) ^b	
Hope (since 2020)	UAESA (UAE)	Global	Emirates eXploration Imager (EXI) ^c	Atri et al. (2022, 15–83 and 94–100) ^f

^aFrom Siddiqi (2018) until ExoMars.^bFrom Li et al. (2021).^cFrom EMM (2021).^dSee Stooke (2012).^eComplete map under planning.^fAtlas format.

What is the rationale for mapping over and over with slightly different, if not identical, spectral bands and resolutions (see Coles, Tanaka, and Christensen 2019)? Whereas planetary science is unquestionably about the advancement of knowledge, its political signature should not be ignored. To this day, every space agency that set up a successful mission to Mars has produced its own map repository of the planet, as if it is bestowing something special. It is then impossible not to remember the early ages of cartography when it was under the control of powerful elites who had been exercising dominance over it for centuries. Unlike on Earth, access to cartographical data is exclusively granted by national space agencies, which are the only ones to be Mars-capable at present. Areographical knowledge is thus filtered by a handful of actors who decide, in the end, what they want or not to show. This also relates to the debate of visual authenticity vis-à-vis scientific objectivity (Daston and Galison 2007). Whilst most of the world is currently following ethics of transparency by maintaining open and easily accessible archives in a systematic manner (e.g., EMM 2023; ESA 2023b; GRAS 2023; ISRO 2022; JAXA and ISIS 2023; NASA 2022b), others, like Russia, have been keeping a certain secrecy on their missions by not having such databases. Additionally, it is curious how some visual and straightforward information, such as cartographical materials, are willingly communicated but that the making process and other technical data sometimes remain in the shadows. This, for instance, required NASA to arduously seek an exchange with the China National Space Administration (CNSA) to obtain the orbital data of *Tianwen-1* (Foust 2021). It turns out that Mars mapping is overwhelmingly performed as part of independent national space programmes. Beyond the purported scientific objectives that are usually common, a clear appropriative aspect transpires from these recurring efforts. Even if this seems to defend intellectual and national pride, these actions are inevitably amenable to territorial logics.

On a different note, the International Astronomical Union, through the Working Group for Planetary System Nomenclature, approves and registers the name of all planetary surface features in the *Gazetteer of Planetary Nomenclature* (IAU 2024). For this reason, official names of places on Mars follow a centralised and regulated protocol. First, the enormous number of names allows virtually every square of Mars to be identified. There are currently 2,061 entries in the database for Mars, each having its own coordinates, diameter, approval date, and origin. Second, a puzzling map of Mars, which is most likely the first of its kind, presents regional boundaries of the planet (Figure 3). Delimited and overlapping lines can be seen. In fact, all these names, points, and lines are eminently artificial and witness the arbitrariness, contestation, and consensus usual to the social process associated

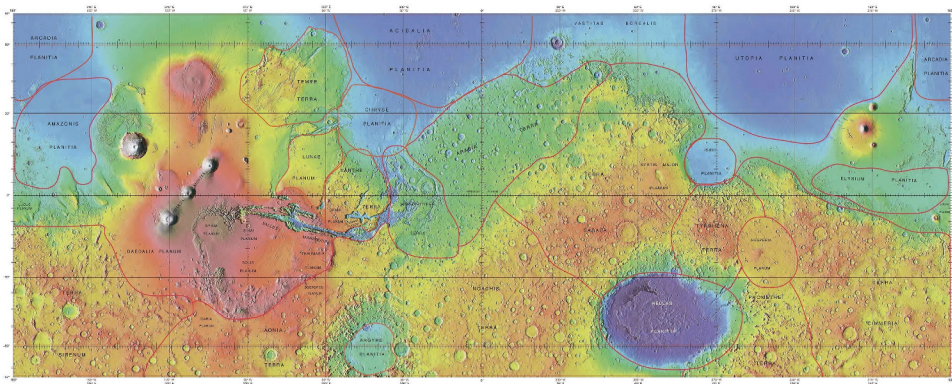


Figure 3. Map of Mars with approximate regional boundaries (IAU Date unknown, detail). CC BY 4.0.

with territoriality (Paasi 1998). Most importantly, this (b)ordering method is just another political technology, which is equivalent to territory-making.

From a vertical perspective, several elements also account for territorialisation. On the one hand, atmospheric analyses performed by flyby and orbital spacecrafts, and on the other hand, surface and subsoil examination executed by landers and rovers allow a volumetric encounter with the planet by processing the mass of matter. Moreover, the Mars 2020 mission's helicopter *Ingenuity* uniquely enables a full presence by occupying the Martian lower atmosphere. This is how the two-dimensional cartographical representation is transcended. The atmospheric composition and meteorological data, such as temperature, pressure, hygrometry, or wind indications have been collected at the overground level (Siddiqi 2018). This has also been the case for seismic information or soil composition at the underground level.

Whereas first observations were inaccurate or even imagined, the modern age has brought technological advances, transforming the knowledge of the Martian surface into reliable databases and making the planet's volume the latest stage of scientific capability. Mars has been more sensed and surveyed than most of the celestial bodies in the Solar System. The eminent scientific nature of missions on Mars must nonetheless not conceal the political meaning it embeds. They are located at a crossroads with material and discursive practices where measurement, calculation, comprehension, coercion, organisation, and ordering all constitute a political technology, that is, territorialisation. Whilst the sophistication and the number of probes have enabled a powerful grasp on the planet, the cartomania of space agencies reflects the historical and social construction of Mars as, above all, a piece of territory to be reproduced in national publications in order to demonstrate capacity. Such an areometrical work does not only create an empty territory but actualise the resources it contains: the latter become in the process of making the former.

***'Prospect to Product...'* the Commodity Frontiers: A Path towards Resource Extraction**

The 'prospect to product' idea is related to the In Situ Resource Utilisation (ISRU) capacity as hinted by NASA (Sander and Kleinhenz 2023, 10). The 'LIVE: Develop exploration technologies and enable a vibrant space economy with supporting utilities and commodities' plan was reiterated during a presentation to the NASA Advisory Council on the ISRU strategy; accordingly, 'scalable ISRU production/utilization capabilities including sustainable commodities on the lunar & Mars surface' were detailed into four categories: 'commercial scale water, oxygen, metals & commodity production'; 'commodities for habitats & food production'; 'commodities for commercial reusable in-space and surface transportation and depots'; 'in situ derived feedstock for construction, manufacturing, & energy' (Sander and Kleinhenz 2023, 8). As a matter of fact, the ISRU strategy exceeds a mere technical dimension. Hence, it is embedded in plans such as LIVE, where commercialisation and commodification of celestial bodies are explicitly mentioned and pursued. Whilst much of the attention is on the Moon, Mars is also unsurprisingly a target. This is consistent with the gradual widening of outer space perspectives set by the Artemis Programme and the broader deepening of space exploration and exploitation aimed by the eponym Accords.

'Commodity-widening' is a process which is worth examining here as humans genuinely seem to be at the dawn of the Martian commodification; it is defined as the 'spatial extension of nature appropriation, via expanding territorial claims to the control and use of natural resources and associated acts of dispossession' (Banoub et al. 2021, abstract, emphasis added). Three practices are constitutive of this strategy: 'identification (discovery), evaluation (selection), and control (exclusion)' (Banoub et al. 2021, 1547).

In the first place, geographical exploration, which consists of identifying and evaluating concentrations of ecological surplus, is commonplace for mining. Indeed, when looking at Mars, many probes have carried instruments that sensed the planet's structure in order to figure out the areological profile. This is how molecules and chemical elements present on the Red Planet have been identified and quantified. When understood as part of current plans, like LIVE, this explorative dynamic shifts into a much more exploitative one. Infrared spectroscopic instruments embarked on spacecrafts have been mapping Martian mineralogy from the surface and also from orbit to reveal its composition (Ehlmann and Edwards 2014). Chemical measurements supplemented this in both locations through in situ data from Mössbauer spectroscopy of Fe-bearing minerals and X-ray diffraction. Recently, they have notably been performed by *Mars Global Surveyor*, *Mars Express*, and *Curiosity*. The discursive presentation of *Curiosity*'s mineralogical analysis is quite telling as well. The first goal of the Mars Exploration Programme was to

‘determine if life ever arose on Mars’ (NASA 2023b). This is how missions on the Red Planet have been looking for organic evidence. Whilst the rover was en route to a mountain with such potential, NASA published an article entitled *Curiosity ready to drill for gold at the Kimberley* (JPL 2014). This metaphor is a stark example showing the embeddedness of traditional earthly extractivism in Mars exploration. Whereas it was referring to ‘black gold’ (i.e., carbon) (JPL 2014), the way this element-seeking was announced inevitably reminds the resource prospect the agency is conducting. Consequently, the materials that are being extracted there are the ambiguous outcome of an officially explorative operation and a suspected exploitative prospect. In the end, Mars appears to be a field of holes left by drilling works typical of mining (Figure 4), in which the alleged scientific exploration of the underground is a necessary step for paving the path towards possible exploitation in any case. This blurry twin-track approach between exploration and exploitation is something already happening in the deep seas in the view of resource security strategies (Bass and Chakrabarty 2014).

Then, the ‘opening-up’ (Banoub et al. 2021, 1548) of new areas for commodity production through legal and regulatory reforms is usual in the widening process. Indeed, as resource utilisation is a driver of outer space exploration, space agencies have been putting a special emphasis

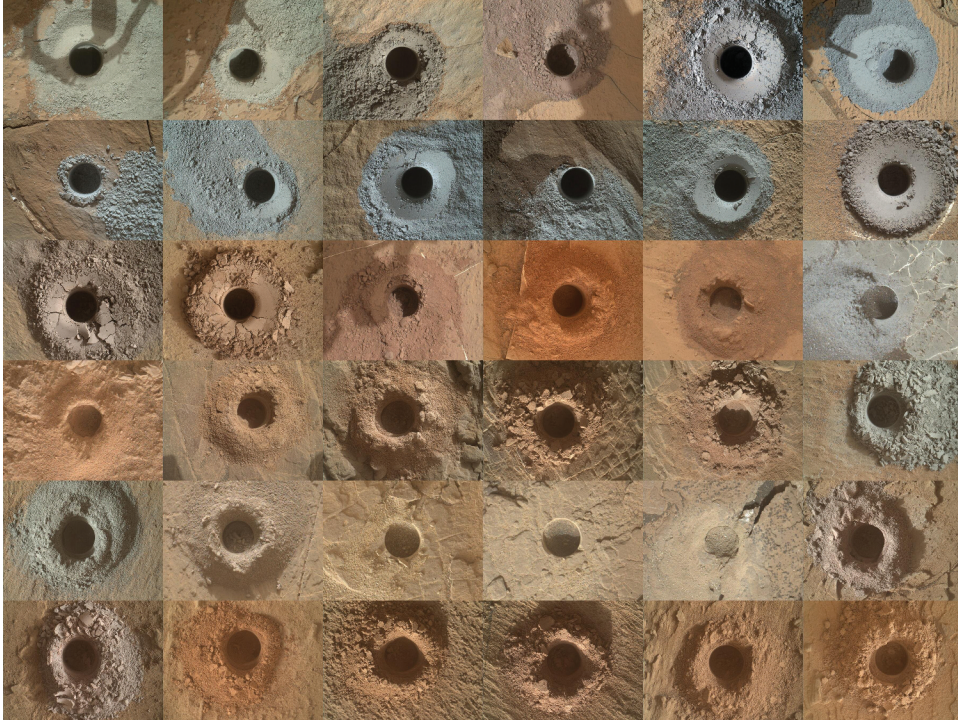


Figure 4. Pictures of *Curiosity's* drill holes (NASA/JPL-Caltech/MSSS 2022a). Public domain.

on that in their agendas (Artemis Accords 2020; ESA 2019; Huaxia 2022), and so has the growing industry as well (David 2023; Wall 2022). In that regard, several nations have recently started to create legal frameworks to allow the exploitation of space resources. In a historic initiative, the US Commercial Space Launch Competitiveness Act (2015) has given American citizens ownership rights for extracting resources in outer space, amongst other provisions:

A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource. (para. 51303)

Other countries, like the UAE, Japan, and Luxembourg, have created comparable national legal regimes for resource exploitation (Act on the Promotion of Business Activities 2021; Federal law 2019; Loi du 20 Juillet 2017). In 2020, the Trump Administration worked to advance a future international framework known as the Artemis Accords (2020), which directly address the question of outer space resources, along with an executive order that supports their development (Executive Order 2020).

Finally, the commodity-widening as part of the larger commodity frontier expansion must be unveiled from its *geopolitical gaze* (Ó Tuathail 1996). The treatment of outer space as a resource to be mastered and exploited by humans – or *res nullius* –, that is subversively substituting the internationally agreed approach for global commons – or *res communis* –, is a hallmark of the logic of empire (Havercroft and Duvall 2009). Similarly, the convergence of realist and liberal ideologies allowing the market to thrive within a world dominated by inter-state competition for power is another imperial signature. In fact, all the countries that are aspiring to tap outer space resources have been building a commercial framework whereby private actors would be leading the race, whilst the states would be protecting their rights. This symbiosis between individual economic impetuses and national interests is a phenomenon that cannot be neglected. In that respect, the reading it can be made from NASA's recent choice for market reliance to obtain lunar regolith (Wall 2020) or the selection of Space X (Brown 2021) and Blue Origin (O'Shea 2023) for joint-venturing to the Moon is sobering. And most obviously, empires have a history of territorial anchorage.

Martian resources are the result of a prospected production that equates to the extension of commodity frontiers. The ISRU is the main topic which highlights that matter. Commodification takes place following a strategic pattern, as indicated by material and discursive actions. Even though the current situation is only displaying a 'commodity-widening', respecting that logic would inevitably find 'commodity-deepening' and 'commodity-transformation'

further in that direction (Banoub et al. 2021, 1535). Claiming space is not foreign to this process, as it is also about spatial control and institutional upheaval. Resources are not found nowhere: it summons the container that is crucial for its making, so that territory becomes another consequence.

An OOO Approach to the RT Sub-Nexus: Probe-Power Stressing the Bonds Between Terrain, Land, and Resources

Dissecting the Potential of Probe-Power

The probes that have been sent to study Mars are *powerful*. They act as a tool-power that is brokering territory and resources. A few comments can be made here on the premises of probe-power. Firstly, it is about Martian probes being ‘autonomous’ and ‘irreducible’ (Meehan 2014, 217). The robotic experience from Mars not only shows an instance of tool-being but also offers an insight into the evolution of such a nature. Even more so than before, spacecrafts sent to Mars are made of extremely advanced technology. Whilst the first flyby-crafts and orbiters were primarily guided by ground-based manual control, Martian rovers are nowadays demonstrating autonomous capabilities. This progress has been constant with each new mission. The most recent one launched in 2020 by NASA, *Perseverance*, is equipped with enhanced automation through, for example, the use of artificial intelligence (NASA 2022a). Its ability to navigate and work more autonomously (NASA 2020) enables it to perform more complex and independent tasks compared to its predecessors. This certainly answers to the need to overcome the challenges of long communication delays, the unpredictable nature of Mars’ environment, and the desire for more efficient mission execution. These technological innovations have thus significantly increased the independence of Martian spacecrafts with time, making the impression of their ontological autonomy even stronger. The discursive presentation of the rovers is also very telling in this regard. All of NASA’s Mars rovers are described with human attributes. As such, they have diverse sensors referred to as a ‘neck and head’, ‘arm’, ‘hand’, ‘eyes’, or ‘ears’ (see NASA 2023d). Additionally, rovers from all nations had a ‘selfie’ of themselves communicated by their respective space agencies (Figure 5). This ‘photograph that one has taken of oneself’ embeds a special meaning anchored in the context of the social media era (OED 2023). Put more clearly, taking that kind of picture is typically a social, deliberate, and human act. By naming rovers’ instruments with human organs and entitling publications on their command executions with social behaviour, space agencies are going beyond the mere use of appealing and trendy terms to taut their assets; they truly anthropomorphise these machines, that is, present them as able of freedom and having integrity. Therefore, ontologically assuming that Martian probes are autonomous and irreducible completely changes the perception of the growing technological capabilities of these machines.

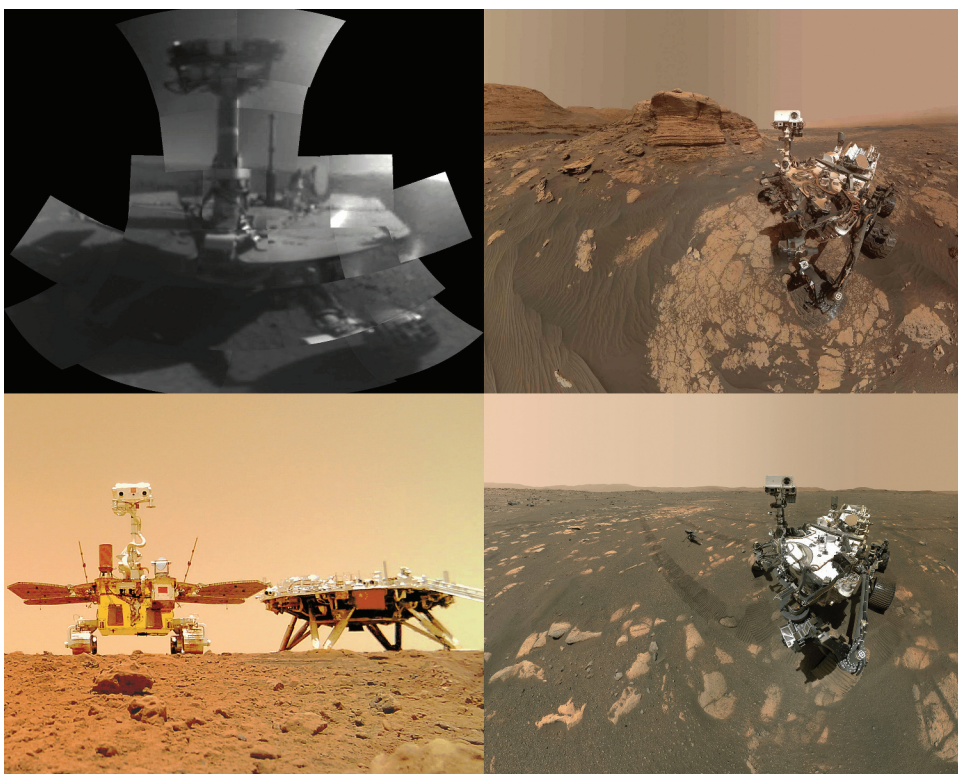


Figure 5. Selfies of four Martian rovers. Note: chronological order clockwise from the top left-hand picture; *Opportunity* (NASA/JPL-Caltech 2018), *Curiosity* (NASA/JPL-Caltech/MSSS 2021a), *Perseverance* (& *Ingenuity*) (NASA/JPL-Caltech/MSSS 2021b). Public domain. And *Zhurong* (CNS 2021). CC BY 3.0.

Secondly, it is about Martian probes being ‘force-full’, that is, capable ‘of an effect, however banal, potent, or radically transformative’ (Meehan 2014, 217). It seems here instructive to distinguish the different types of Martian probe. There are four main kinds of spacecrafts on Mars: flyby-crafts, orbiters, landers, and rovers. Each of them has an effect but to a dissimilar extent. The two formerly mentioned ones are spatial objects strictly speaking, and they were the first to go there. They move around the planet by staying in the space vacuum or only maintain a meagre physical contact through the upper atmosphere, except when they crash on the surface. At the same time, this remoteness is crucial in collecting some atmospheric data and particularly in permitting a large-scale overview of the planet, which has been very much at the centre of the attention of both scientists and the public (see *supra*). These images from above and subsequent maps have been determinant in (re)defining the vision of the Red Planet, shaping missions’ design, and making those voyages happen outright. Contrarily, the two latterly mentioned ones are terrestrial objects by essence and arrived there later, often based on prior information collected by their spaceborne relatives. Indeed, these objects are

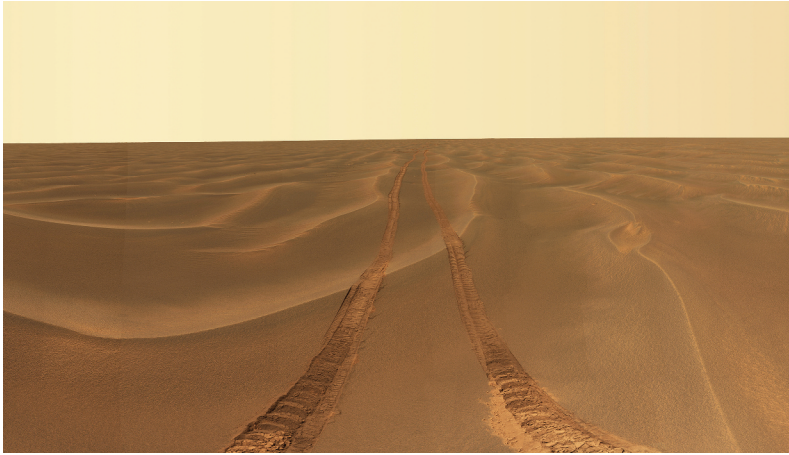


Figure 6. *Opportunity's* track-prints in Meridiani Planum (NASA/JPL-Caltech/Cornell 2005). Public domain.

destined to stay on the surface forever when sent to Mars. The physical footprint of these probes is thus considerable. In the most striking sense, they leave extensive track-prints all over the planet when crisscrossing it (Figure 6). They look like scars on the Martian surface that are visible far from above (NASA/JPL-Caltech/University of Arizona 2014). The communication of NASA specifically underlining this phenomenon further conveys the idea that the planet is and will be different after the passage of its rovers, even if the Martian winds may erase them. In a more underground sense, most of the landers and rovers have been equipped with digging tools that enable them to foray into the Martian surface (Figure 4). Whilst early spacecrafts such as *Viking 1* and *Viking 2* landers only had a 'remote sampler arm' (Siddiqi 2018, 129 and 134), later probes, like *Spirit*, were equipped with grinders or even drills for the more recent *Curiosity* (NASA 2023e) and *Perseverance* (NASA 2023f) rovers. These are much more invasive and able to dig holes of several millimetres into hard rocks. Curiously, none of these technologies are embarked on the only rover from a different space agency currently in operation, *Zhurong*, sent by CNSA (Zou et al. 2021). Besides, pictures taken by them are processed and thereafter communicated outside the missions' team to build a community of enduring supporters through the portrayal of a 'Martian picturesque' (Vertesi 2015, 217). Hence, every spacecraft operational on Mars does not entail the same degree of effect. In fact, NASA's rovers are not only overrepresented but also the most marking of all spacecraft, thereby allowing the US to tick all the boxes of effect on Mars. This is not without raising questions about the geopolitics of outer space exploration, as what unfolds on Mars seems to be reproducing traditional earthly western-hemispheric domination patterns. If the overwhelming presence of the US must be highlighted, the astonishing pace at which developing countries are

becoming Mars-capable cannot be understated. Just in the last decade, three of them were successful in reaching the Red Planet with a large diversity of spacecrafts (Table 1), obviously giving them forcefulness. Even if the lag of effect might just reflect different agendas (see *infra*), it also brings the matter of its quality and not only quantity. As these developing countries have been putting an exceptional effort in order to have their Martian premiere, the stakes at play and the subsequent impact of the probes in the respective nations must be remarkable, compared to NASA that is somewhat struggling to get continued funding and support (Foust 2024; Vertesi 2015). Therefore, the picture of an almighty America as on Earth so in outer space, alongside an ever-fledgling developing world hardly maintaining its existence beyond earthly limits, should be nuanced.

Thirdly, *power* emerges as a result of the ‘alliances of objects and practices’; here, the ‘*infrastructures of power*’ understood as the assemblage of elements that contribute to the empowerment of spacecrafts must be explained (Meehan 2014, 217, emphasis added). The operational infrastructure appears to be a noticeable aspect. The capacity factor has been decisive in shaping the feasibility of these missions. In a financial sense, the costs of launches to Mars are amongst the most prohibitive in the history of space exploration. They are therefore strictly limited to states possessing such an affordance capability. Both *Vikings* have, for instance, topped at the third position *ex aequo* in the ranking of the most expensive robotic spacecrafts ever launched by NASA (and most likely the world), with its US\$2.9 billion value, entering by the same token in the 10% of the planetary science’s missions with the biggest expenses (Dreier 2020). Unsurprisingly, rover missions are significantly costlier than other flyby or orbital ones. NASA or CNSA can, for example, enjoy enormous flows of funding from their respective governments. In that regard, the US spent US\$61.97 billion and China US\$11.94 billion in 2022 (Euroconsult 2022), which ranks them as the countries with the most extravagant space budgets in the world. In a human resource sense, NASA can, for instance, count on the basis of 312,000 people, of which approximately 18,000 are direct servants, including top-level specialists (NASA 2023a). In a similar fashion, an estimate claims that more than 100,000 people work for the Chinese space programme (Shubber 2013). In a scientific sense, engineering and science instruments are extolled for their potential, genuinely portraying these machines as technological marvels. *Perseverance* was proclaimed as ‘humanity’s most sophisticated rover’, embarking ‘incredible science’ and following what, the NASA administrator confessed, ‘as a mission, as an agency, and as a country, [...] we will persevere’; the JPL director further added that ‘Perseverance is the most capable rover in history’ (Potter 2020). This is a sound example of how the Martian endeavour for global science is intimately tied with the one of a nation. Surprisingly, a much demurer narrative was heard from the Chinese side, which has rather put forth the

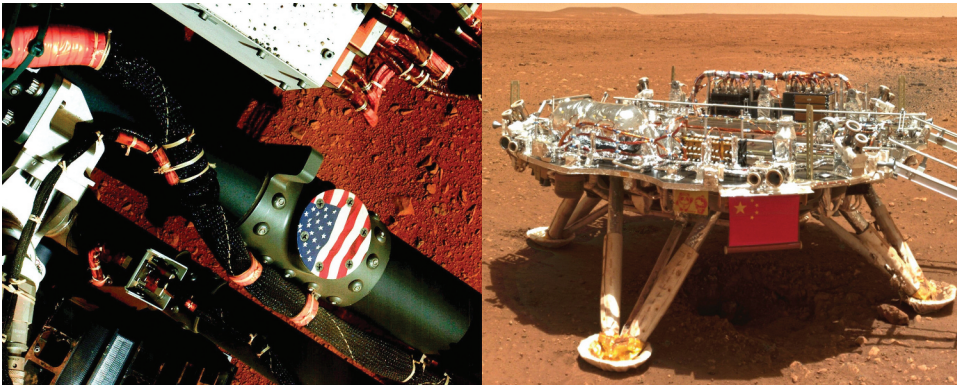


Figure 7. Flag marks of two Martian rovers. Note: chronological order from the left picture; *Curiosity* (NASA/JPL-Caltech/MSSS 2015). Public domain. And *Zhurong* (CNS 2021). CC BY 3.0.

challenge and collaboration the mission represents (Huaxia 2020). This brings the symbolic-political infrastructure, which cannot be neglected. Most visibly, every rover on Mars has a flag mark of its sending nations on it. Space agencies are keen on posting pictures displaying it (Figure 7). Notwithstanding their innocent appearance, this is a paramount demonstration of the connection between the material and the discursive power of these robots. In fact, Martian rovers act as representatives of their countries. Consequently, probe-power is generated through various infrastructures at the material level, with the involvement of financial, scientific, engineering means and political symbols; and at the discourse level with the communication of space agencies.

From a more intimate viewpoint, the anthropology of Mars exploration sheds an instructive light on probe-power. In an apparently unhumanned world, there are regiments of scientists and engineers that actually ensure the uneventful progress of missions on the Red Planet millions of kilometres away from the Blue one. For that purpose, these specialists have altogether adapted their habits and even ended up developing new demeanours. Most noticeably, working with landers and rovers located on Mars has necessitated the adoption of a new timekeeping standard: the Mars-day, also known as Sol. More than just keeping, it is also a making process in which human and technological factors are involved in the naturalisation of an artificial construct (Mirmalek 2020). Even more baffling is the visualisation and embodiment practices leading mission team members to *see like a rover* (Vertesi 2012). In resonance with post-phenomenology, the vision and kinaesthetics of the robots are appropriated as being oneself. They project the rover's characteristics on themselves through a '*technomorphic move*' (Vertesi 2012, 400). In addition, the pronoun *we* is used to describe something considered as a co-worker. Rovers even fit into social classes. In this assemblage of machines and humans, a flat ontology, as encompassed by OOO, prevails. Indeed, the team members equally exist with the rovers, so that they both become objects.

From this perspective, the robotic objects are given a *powerful* status. They compel human objects to adapt to their own environment, rhythm, and body. Therefore, rovers hold a special position in the human-robot relationship. Compared to orbiters, flyby-crafts, or even landers, their physical proximity with humans, as well as their demanding feature, perhaps place team members in a humbler interaction with them through the actual will to access their real nature. The withdrawal of these robotic objects is salient here.

Evidence of the potent dimension of probe-power is numerous. First, the mutual avoidance of landing sites on Mars is to be remarked. Conversely to non-surface spacecrafts that are readily at risk of collision, Martian landers and rovers neatly avoid themselves, except for same-flag counterparts (Lakdawalla 2020). As if nations were somehow acknowledging a tacit territorial recognition, Martian surface spacecrafts have always been sent to different locations with sizeable distances between them, which repeatedly exceed a thousand kilometres. The only exception is the planned joint ExoMars mission with the European Space Agency (ESA) and Roscosmos near the *Pathfinder* and *Sojourner* landing site. Nonetheless, it is on standby probably because of the repercussions of the Russo-Ukrainian War. During the Cold War, this phenomenon was even more striking as the USSR was only planning surface missions in the southern hemisphere, whilst the US was doing likewise in the northern hemisphere. Was that an attempt to incorporate Mars into the bloc division of the world? Second, despite the availability of remote-sensing instruments, like the *Hubble* telescope, flyby-crafts and orbiters are still being sent to Mars. In other words, even if quite similar results can be obtained more easily, there is an insistence on sending that kind of probe there to conduct

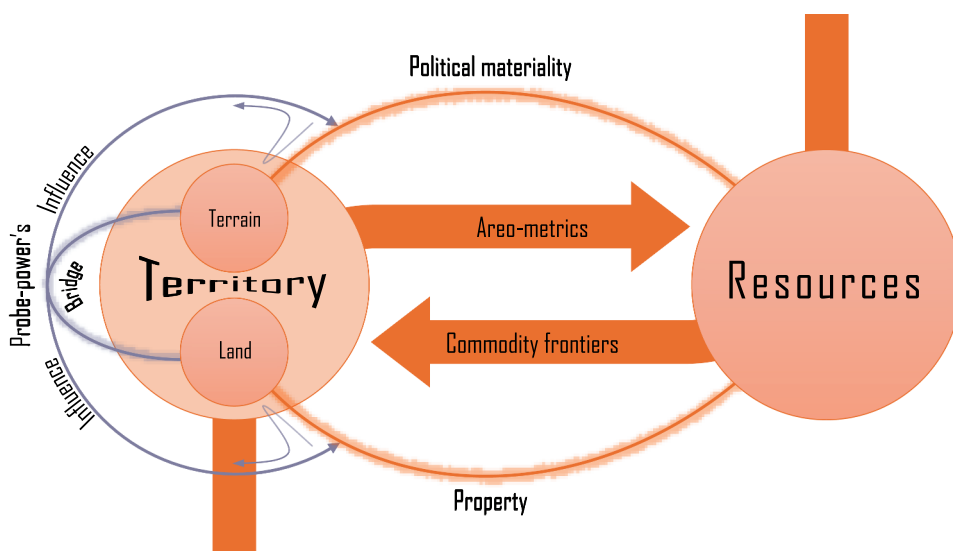


Figure 8. The Martian resources-territory sub-nexus.

in situ research. Having those entering in contact with the Red Planet is preferred, as if it was granting something special. When applied to territorialisation and commodification, probe-power can thus emerge as a contributing entity. It strengthens territory and also resources by stressing the respective bonds the sub-elements have with the latter (Figure 8). Hence, Mars is being shaped into a ‘technological zone’ where technology can expectedly ‘establish boundaries around [...] a firm or a nation-state’ (Barry 2001, 25).

Stress on the Political Materiality of Terrain-Resources and the Property Feature of Land-Resources Bonds

Terrain is connected to resources via the political materiality they have in common (Figure 8). Whereas the political materiality of resources has been addressed for a while, the one of territory has only recently started to be the focus of an active discussion (Elden 2013), especially through the helpful concept of *terrain* (Elden 2017). This sub-element is not straightforward, as it is nested in the core of territory by essence. It combines two ‘fundamental registers’: ‘the material and the strategic, the physical and political dimensions of geography’ (Elden 2021, 177). Within these registers, territory and resources have often been analysed in a separate manner. Nevertheless, the latest conceptual evolutions on the territorial side allow for an unprecedented view of their relationship. They not only influence each other but are bonded at an infra level. As such, they share the same substance to a certain extent. Therefore, tampering terrain will automatically feed through resources and vice versa. This also means that territory will be affected in such an event, as a suprastructure. The *dynamic materiality* (Boyce 2016) of terrain reminds that even if human action is being exercised in territorial production, it can neither be entirely controlled nor appropriated, as visible in the inherited landscapes that are the result of a myriad of phenomena also comprising more-than-human agencies (Elden 2021). This is precisely how probe-power meets terrain. Acknowledging that Martian probes are a source of power and the terrain on which some of them operate is shaped by non-human actors confirms the involvement of both registers. Martian rovers contribute to the territorialisation and commodification of the Red Planet by stressing the terrain-resources bond, that is, political materiality.

Land is also connected to resources via the property feature they have in common (Figure 8). The remaking of property landscapes is indeed an integral part of state territorialisation (Emmenegger 2020). Property is key to the production of state authority, which is symbolically and materially entangled. Therefore, it brings together several registers that form the link between land and resources: the political, the economical, the physical, and the symbolic. This is another common ground that permits a renewed and joined analysis of

territory and resources. They not only influence one another but are bonded at an infra level. As such, they share the same substance to a certain degree. Hence, tampering land will automatically feed through resources and vice versa. This also implies that there are suprastructural consequences on territory. Again, due to the involvement of key registers, Martian rovers contribute to the territorialisation and the commodification of the Red Planet now by stressing the land-resources bond, that is, property.

The Mars Sample Return (MSR) project illustrates these interconnections by reflecting an ongoing change of terrain and land on Mars. It is a collaborative effort between NASA and ESA, with the goal of retrieving samples from Mars and returning them to Earth for detailed scientific analysis (ESA 2023a; NASA 2023c). The MSR project aims to provide a valuable indication of Mars' geology, history, and potential for past and future (human) life. Multiple stages and complex operations are involved. NASA's *Perseverance* rover is currently collecting and sealing Martian rock and soil samples in tubes, first transferring them in its belly and thereafter releasing some of them at strategic locations on the surface of Mars as it drives around. A lander and a vehicle, along with helicopters, are planned to be sent to Mars in 2028 as part of the MSR mission in order to recover the sample tubes left behind by *Perseverance*.

The de facto control that NASA has not only on the sample tubes but also on their locations is telling. What must be underlined here is twofold. First, all the processes necessary for the collection of the samples change the Martian terrain and would appropriate the resource. From extraction to deposition (NASA/JPL-Caltech/MSSS 2022b), the planet is significantly refigured. Drillings irreversibly put a mark on the surface (Figure 4). Even the movements of the rovers leave a trace on the ground, should it be for a shorter period (Figure 6). More strikingly, the deposited tubes create a grid, as they are indexed like surface features with proper names (NASA/JPL-Caltech 2022), following which future displacements will be adapted. Knowing how precious these samples are, it would be inconceivable that spacecrafts randomly rolled or landed on them because of the risk of damage. It could a fortiori be expected from future ones, at least sent by NASA or ESA, that they will set avoidance zones by precaution. Therefore, the scientific and political significance would be enmeshed with the physical dimension of the terrain-resources bond whereby it would be certainly accepted that the chosen sites with these American deposits are henceforth not like before until the MSR. This latter remark points out the dynamism of the Martian materiality due to mission patterns. Second, keeping in mind the identified commodifying trend, it would not be unreasonable to consider these sample tubes as the very first Martian extracted resources to be sent back to Earth if the MSR project was to be successful. Whilst legal aspects may provide specific entitlements, especially on the jurisdiction applying over these objects, the political authority, which is

a type of governmental technique, being vested in NASA and ESA by enabling them to control the access to and property of these resources to some extent is instructive. Would not the Martian property landscape be sharply modified by such a project? As a matter of fact, NASA has demonstrated that it is not the only agency that has the obligation to be involved in such a project to retrieve its own material. MSR will thus be conducted in collaboration with its European partner. It is believed that the MSR samples will benefit from a cooperative mindset. Notwithstanding, there are no guarantees that their content will be shared with others for the time being. By selecting one agency rather than another one, Martian extracted substratum inside the sample tubes could become the product of arbitrary and exclusive management, thereby determining an ad hoc Martian property regime. Hence, this practice would interweave the political, economic, physical, and symbolic dimensions in a way that resources could be intimately linked to territory through terrain and land. The unfolding commodifying and territorialising phenomena would become more consubstantial than ever due to the stress put on the bonds between the two necessary conditions of territory and resources by probe-power. Furthermore, it builds a territorial bridge connecting the territorial sub-elements by capillarity when influencing those bonds, all through the infrastructures of power.

The discourse on outer space materiality and factual property regime is also insightful. NASA's head has raised concerns regarding a Chinese lunar land grab. Whilst being legally prohibited, the US is already assuming such a risk (Bender 2023). This confirms that outer space, by reason of the resources it possesses, whether on the Moon or elsewhere, is becoming a conspicuous question of *what* and *who* over the ownership. By condensing outer space resources in a mere matter of political materiality and property, related actors corroborate the fact that celestial bodies are caught between territorialising and commodifying dynamics also through terrain and land, in which resource enclosures can substantially translate into territorialisation.

Conclusion

This study has inevitably questioned the ontology for engaging unearthly terrestrial spaces, that is, outer space *terrae*. On that point, more-than-terranism (Olson 2023) is a useful initial framework. Peters, Steinberg, and Stratford (2018) have more precisely challenged the persistent 'grounded' (p. 5) territorial approach by introducing fluid ontologies in order to have a more complex grasp of dynamic and indeterminate spaces. If continuing on that path, would not an utterly xeno-earthly and -terrestrial ontology of territory be explicitly required? The diversity of worlds with manifold and unsettling states of matter that can be found in outer space calls for an even more complex ontological rethinking vis-à-vis territory. Advances in physics and the

extension of human presence in the cosmos compel spatial ontological concepts to constantly adapt as a consequence. Yet, the Martian experience teaches that the planet has very often been treated in a terran fashion. The similarity of the landscapes between Earth and Mars is deceiving, and people usually forget that they are, in fact, very different. In the same vein, the high level of technology used in outer space exploration can be misleading regarding the physical discrepancy existing again between Earth and other parts of the Universe. Gravity, temperature, and pressure, to name a few, can be drastically dissimilar. The time needed to reach Mars is illustrative. Whilst a humanned mission would take months, even the tiniest bit of information travelling at speedlight takes at least more than three minutes. There has recently been progress in better taking into account the laws of physics in the geographies of territory and resources, with the addition of a third (Elden 2013) and fourth dimension (Childs 2020). A call for an ontological shift for analysing territory in contexts foreign to Earth and terrestriality is therefore made, as missions go further in the cosmos (Figure 9).

Moreover, this study has been limited to the RT sub-nexus by assuming the relationship between state and territory throughout. That being said, it is undoubted that the question of state will become an utmost priority, as the private sector is encouraged to encompass the Martian realm. The modern

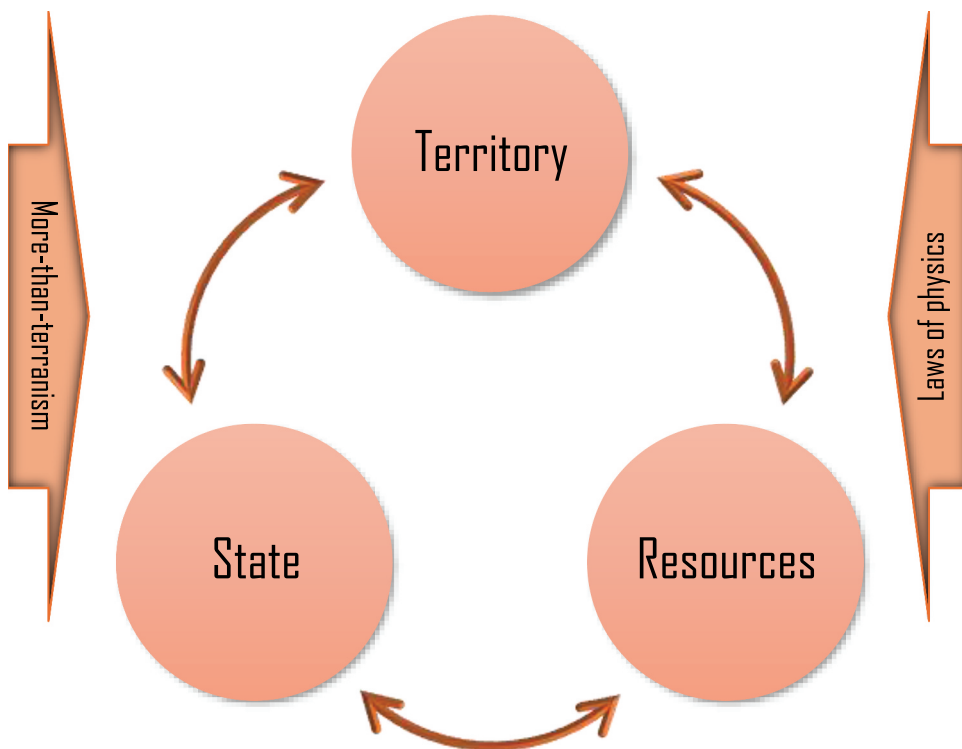


Figure 9. The outer space resources-state-territory nexus.

state's 'impermeability', 'impenetrability', and 'territoriality' were conceptualised as a result of the Peace of Westphalia (Hertz 1957, 474). The current international system is made of 'territorially defined, fixed, and mutually exclusive enclaves of legitimate dominion' (Ruggie 1993, 151). In other words, state and territory are consubstantial to Westphalian sovereignty. The classical 'regime theory' allows sovereignty to be delinked from terrestrial territory and recreated in outer space (e.g., ISS) following a conservative approach; alternatively, a more liberal approach disconnecting the state from territory and making humanity a central element is proposed through 'cosmopolitan sovereignty' (Stuart 2009, 9). Somewhere in between, thinking about the existence of an alter-*Leviathan* will emerge as essential if the international system wants to preserve the sacrosanct state-territory-sovereignty consubstantiality in the *New Space* age. Some options have been proposed to take up this challenge, like the 'zones model', 'united space model' (Leib 2015, 16–20), or a 'bounded first possession' approach on Mars (Bruhns and Haqq-Misra 2016, 61). But there are definitely more to be explored (see Dapremont 2021). Future investigations will hopefully offer a deeper understanding of that issue and, by the same occasion, the broader RST nexus, should it be in outer space or on Earth.

In closing, Martian probes have revolutionised the relationship with Earth and how humans interact with the Red Planet. Even though a 'one small step' à la Armstrong is likely not to occur any time soon on Mars, what has been achieved so far is close to the intensity conveyed by the quote. This study has argued that this apparently isolated, empty, and virgin place has been being reworked by Martian actors' hands into something deeply political by formalising, utilising, and advancing a novel theoretical framework. The RT sub-nexus has brought to light the areopolitical transformations of the planet. A nexus thinking has enabled to explicitly catch the complex interrelations that exist between territory and resources. Whereas separately focusing on them would have been possible, it turns out that this holistic approach critically enhances the understanding of territorialisation and commodification on Mars. As a result, this study not only shows that territory is being made by areometrics and resources by commodity frontiers but that these dynamics mutually influence each other. As a matter of fact, areometrics participates in resource-making and commodity frontiers in territory-making. At the same time, the atomic structure of territory involves the existence of bonds between its sub-elements and resources. Terrain shares with resources their political materiality, whereas land shares with resources their property feature. In fact, these bonds are more substantial than the sub-nexus, thereby welding rather than connecting these sectors. And, the robotic representatives on Mars have revealingly stressed this consubstantiality.

A startling aspect of the global Martian endeavour is that it has until now remained unhumanned. Indeed, a whole range of robots are executing diverse

tasks on behalf of their senders. The fact that this interaction is exclusively intermediated, in a way that Mars is becoming a technological zone, can therefore not be ignored. By adopting an OOO, this study has also underscored the power of probes sent to Mars. It has resulted that these machines, especially rovers, are indeed autonomous, irreducible, and force-full. Having that said, the assemblage of infrastructures in which they are inserted achieves to bestow power upon them. This is how probe-power is generated on Mars. In this regard, it has been demonstrated that it stresses the relationship that terrain and land have with resources, respectively. Besides, probe-power functions as a territorial bridge between those, which means that it brings together the constitutive elements of territory. Whilst it is difficult to assure that this arithmetic is tantamount to territory, it is nonetheless a reinforcing factor and, more consequentially, an argument supporting the consubstantiality of territory and resources. Hence, an alternative insight into the rationalities of territory is also presented.

The adoption of selected paradigms has further supplied depth to the study, in addition to the width offered by a nexus approach. Volumetrisms, apparatus, post-humanism, post-geocentrism, and post-modernism in general, have guided this work by unveiling innovative perspectives on the Martian spatial political reality – or what here established as areopolitics.

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