**Immersive terrain: The US Navy, Sealab, and Cold War undersea geopolitics**

**Abstract**

Like ‘territory’, *terrain* is a term that has been tied to its etymological roots on terra. This paper seeks to release terrain as both concept and practice from the terrestrial through an analysis of the Cold War era case study, Sealab II. This little studied project, led by the US Navy, sought to establish the feasibility of sustaining life under the sea and in doing so, provides a rich site of analysis through which to explore the notion of terrain that exists *in* volume, rather than simply on the earth’s crust. Within this immersive voluminous framework, the function of the body is also re-examined as both a site that experiences terrain, but also one which became a terrain of sorts during the Sealab experiments. The paper concludes by suggesting that understandings of terrain within geographical scholarship would be enriched were they to push off from the earth’s surfaces and argues that there is a need to re-think terrains’ relational aspects, re-root it from terra, and re-orientate it towards the body.

**Keywords:** Terrain, undersea-space, Cold War, geopolitics, elemental, body

**Introduction**

*Terrain*, as Stuart Elden (2010) has highlighted, is a term or concept that is deployed with little conceptual precision within geographical scholarship. Like territory, it ‘seems so obviously universal’ (Elden 2010,780) and is used, often straightforwardly and uncritically in both academic and colloquial discourse to describe the lie or formation of land or to assess its geomorphological properties. Like *territory*, it is also a practice and concept that has been resolutely tied to its etymological roots on ‘terra’. This is beginning to change with *territory* which is now conceptualised as a complex and processual assemblage of the economic, strategic, legal, and technical in multiple volumes (in the air, sea, beneath the ground as well as on land) rather than a flat, bounded space over which sovereign control is exerted (Elden 2013). *Terrain* as of yet remains outside this expanding body of work on territorial volume and volumetric thinking. If we are to take seriously the concept of territorial volume, then terrain, as a constitutive element of territory need also be released from terrestrial constraints (see Elden 2010, 2014). Not only would this deepen and enrich understandings of territory within geography but it would enable a rethinking of terrain as a political-strategic relational practice (Elden 2010) that exists and functions within the world’s volumes rather than merely on the earth’s crust.

These ideas are explored in this paper through a little-known Cold War era military project, Sealab II – a pioneer effort by the US Navy to support human life beneath the sea. The military lens here is a useful one as the analysis and manipulation of terrain has long been associated with military operations that see the earth and land studied, analysed, managed, and manipulated to achieve both defensive and offensive strategic objectives (Doyle and Bennett 2002). As Doyle and Bennett (2002, xi, see also US Army 1990) suggest, the ‘landscapes of battle and the geology that underlies them’ strongly influence the outcome of military strategy and they have demonstrated the value of deconstructing ‘terrain’ in order to interrogate these effects further. This paper begins by briefly situating the Sealab case study within its geopolitical and temporal context before exploring the Sealab initiative in greater detail. It proceeds by engaging with the complex, three dimensional, volume of undersea space, exploring as it does so terrain as it exists on the sea floor, but also as it functions in relation to the inseparable volume of water above. The second empirical section deals with the body as an integral site in which terrain is corporeally experienced, but also how the immersive nature of the underwater environment necessitated that the body itself became a terrain of sorts during the Sealab II project. The paper concludes by suggesting that our understandings of terrain would be enriched by pushing up from surfaces into the elemental volumes within which the earth’s formations exist in order that we might better understand the ways in which the earth, in all of its dimensions, is negotiated and inhabited.

**Dwelling in Cold War geopolitics**

As Farish (2006, 2013) highlights in his work on the Arctic, the geopolitical rivalry and instability of the Cold War provided a backdrop against which militaries would be pitted against the earth’s most hostile environments. Indeed, the US military were enthusiastically studying and engaging with extreme environments and terrains after the onset of the Cold War and increasingly configuring the world ‘as a patchwork of hostile environments’ to be mastered (Farish 2006, 193). Whilst the elemental extreme of the cold north proved a pivotal testing ground for the Army and military scientists, it was oceanography and space science that became the ‘prime carriers of the American flag’, serving to symbolise Western, and specifically US technological achievement in frontier spaces (Doel 200,636). The need, in the words of Hamblin (2002,15), to ‘subdue the ocean environment, to make it a manageable and even an advantageous battle-space’ drove the US Navy to increase its knowledge of the oceans during the Cold War. The Office of Naval Research (ONR) invested heavily in oceanography with the primary aim of understanding more about the environments ‘through which men and machines might travel and communicate’ (Oreskes 2007,699). The Sealab initiative took this one step further. It was an endeavour not to move or communicate in the sea, ‘not to play within it, but to live within it, to dwell’ (US Navy 1965).

Prompted by a recognition of the need for enhanced deep diving capabilities after the loss of the USS *Thresher* in 1963 (Bond 1993), the US Navy (led by Dr George Bond), along with scientists, oceanographers and engineers successfully constructed the first Sealab underwater habitat in 1964. It was subsequently positioned on the seafloor off the Bermudan coast to provide a space for four men to live and work 58m under the sea for three weeks. The men, in a sub-aqua homage to ‘Astronauts’ and before them ‘Aeronauts’, were described as ‘aquanauts’. Whilst they could not claim to be amphibious, capable of living in both air and water, where ‘the limit between the terrestrial and the underwater worlds disappears’ (Le Dû-Blayo 2014,167), the borders between land and sea were as porous as they could be. No door separated them from their watery surroundings, only the pressure of the habitat kept the water at bay as they moved through a hatch to and from the depths of the sea. This way of life continued for 11 days until the project was abruptly suspended due to an impending hurricane. It did demonstrate to the Navy (1966), however, that ‘the deep dark sea is a lot more interesting if you can make man a free agent not just for a few minutes but for a few days’.

The US Navy persevered with its ‘Man-in-the-Sea program’ a year later with Sealab II. Rather than take place in the clear, warm, and favourable conditions of Bermuda’s seas, the Sealab II habitat and aquanauts would experience the more inhospitable conditions of the continental shelf surrounding the US (ONR 1967). Three ten-man aquanaut teams spent 15 days each living and working on the seafloor at a depth of 62m, off Scripps Pier at La Jolla California whilst NASA astronaut Scott Carpenter lived there for 30 days, in what the ONR (1967,i) described as ‘a pioneer effort to support human life and useful activity in the earth’s most hostile environment’. The stated aims of SEALAB II were multiple; in addition to tackling oceanographic problems, it sought to better the Navy’s ability ‘to live and to perform useful work under the sea’ including salvage and rescue operations for submarines, downed aircraft and atomic weapons, to make the sea ‘yield some of its secrets’ on undersea weather systems, and to expand the capabilities of the military on the continental shelf (ONR 1967,17).

**Sealab, sea-life, and the aquanaut**

In order to achieve these objectives, the sea floor terrain was engaged with initially much like a terrain might be on land. Its topography was mapped and charted with detailed cartographic representations produced to depict contour lines working their way around various subsea formations, heights, and depths, peaks and troughs (ONR 1967). Indeed, the site on which the Sealab II habitat would sit was chosen, in part, because of its proximity to the Scripps Institute of Oceanography and the well charted floor surrounding it. After analysing maps, three dimensional models of the seafloor, and sonar soundings, it was decided to place the habitat on one of two branches of La Jolla submarine canyon. Not only would this avoid the steep inclinations and silt deposits identified in preliminary dives, but it provided an ideal area for excursion diving to even greater depths without the aquanauts having to swim long horizontal distances (ONR 1967, 13). Mapped lines and visualisations of the terrain were also utilised to position the Personnel Transfer Capsule (PTC) – a vital piece of equipment to transport the aquanauts, at the pressure of the seafloor, to the decompression chamber on the surface. Traditional terrain mapping practices, however, proved somewhat inadequate to negotiate the ‘extremely uneven and fast changing ocean bottom’ (Culpepper et al 1967,335). Surveys prior to Sealab revealed some of the extent of this change, indicating, for example, that about ‘200,000 cubic yards of sand’ was being lost each year into Scripps canyon as the ocean currents moved and changed above and around the floor (Murray et al 1967,371).

These currents and mobilities shape the seafloor to the extent that the terrain cannot be understood without first paying due attention to the water in which it is immersed and inseperable from. Water as Ten Bos (2009,78) asserts, is ‘pre-eminently apt as a means of surrounding’ and its surrounding matter is dynamic, in constant motion, with molecules constantly making, breaking, and reforming bonds with one another (Bremner 2014). The ocean will not be the same from one day to the next as parcels of water are turbulently ‘exchanged between one part of the moving fluid and another’ (Brown et al 2004,40). A weather station, installed and maintained by the aquanauts, aimed to try and make sense of this fast changing environment and to unlock information about little known undersea weather systems. Underwater weather, is after all ‘as important to man in the sea as to man in the atmosphere’ (Murray et al 1967,371) and similalry inseperable from analysis of terrain (US Army 1990). The measurements taken were similar to those in the air, and incldued the direction and speeds of current, temperature, pressure, and ambient light. This is clearly a complex, multi-dimesional operating environment that cannot be understood through an analysis of the seafloor alone. On the contrary, any strategic relation between sea and military during the Sealab project had to be mediated through the water’s dynamic elemental properties. As Bremner (2014) illustrates persuasively in her account of the search for the missing Malaysian Airlines flight in vast swathes of the sea, the dynamic elemental properties of the water confound and resist human inscription (see also Lehman 2013). To fully map this space would involve following its vectors of movement (Bremner 2014,7) and these mobilities proved difficult to trace for those topside during Sealab. ‘Objects on the bottom at a known location’ wrote Bond (1993,124) were ‘in fact not there, but often found some distance away on a new azimuth. Although we have been moored over Sealab II, an object nearly the size of a small submarine, for nearly a month, we still don’t know precisely where the habitiat lies, nor on what heading’ (Bond 1993,124). This was a dynamic, mobile terrain that did not respect traditional terrain evaluation practices both in terms of accurately visualising the seafloor, and in terms of its temporality. Rather than acting as a relatively predictable geomorphological construction, the undersea terrain was far from static. The ‘lie of the sea’ could not be grasped, it slipped through maps and models which aimed to capture it at any specific moment in time.

We might draw on the case study of Sealab to as ask similar questions of other relatively transient spaces such as air (and other substances such as ice). Like the seas there are myriad factors that could influence an ‘aerial terrain’. An aircraft, immersed in an invisible element, can at any time encounter turbulent air of different densities ‘or air layers moving at different speeds and directions’ revealing a multi-layered terrain that is constantly made and remade as it does so (Christopherson 2009,223). Martin (2011) meanwhile writes of fog as a disorientating and gathering force which can vary in both temperature and luminosity. Like the sea, the air is a terrain that enrols a ‘material geography of flow, flux, and fluidity’ (Jackson and Fannin 2012,437). Perhaps we might also consider the intricate geophysical dialect between the co-constitutive terrains of water and air. We live, according to Ingold (2010 in Adey 2015,57) in a ‘weather world’ (see Christopherson 2009,207), where there is no distinct surface separating earth and sky, but an inter-involvement of land, air, and water. There could, writes Ingold (2008,1803), ‘be no life in a world where medium and substances do not mix, or where the earth is locked inside and the sky locked out of a solid sphere’. The concept of terrain, from this perspective, is complicated as it is uprooted from terra and brought into relation with mobile and malleable volumes.

**Terrain and the body**

In thinking about terrain within this voluminous framework, the relationship between terrain and bodies (both human and non-human) must also be rexamined. As Adey (2015,57) highlights in relation to air, volumes can be immersive in a way that is ‘qualitiatively different’ to Elden’s (2013) more ‘legal, techno-strategic, volumetric accounts of territory and verticality’. In addition to being immersive, they are ‘inhabited’, hinting at a ‘thicker materiality’ that works on and in the body (Adey 2015,71). The sea is, according to Steinberg (1999), inhospitable and unhabitable but Sealab demonstartes that Adey’s analysis of volumes as inhabited and immersive has purchase beneath the sea, opening a fruitful avenue of enquiry through which to explore terrain as it works on and in the body. Indeed, as is reflected in popular culture, human bodies do move, live, and work (albeit temoporaily) beneath the sea and as Merchant (2011,134 and also Straughan 2012) highlights, these submerged bodies are understudied within geography despite the increasinging amount of attention being paid to the sea more generally. Moreover, if terrain is to be understoof as a political strategic, or geostrategic, *relational* practice of power that encompasses both the physical aspects of the earth’s surfaces as well as human interaction with them, then the human body as a relational actor must take a prominent position.

This, however, should not take place at the exclusion of the myriad mobile non-human bodies that interact with humans and form a composite element in the undersea terrain. The sea, as Murray et al (1967,369) highlight, is filled with ‘biological activity of all kinds’. This caused a number of problems for Sealab aquanauts who had to clean the organic growth from measuring equipment every few days (Murray et al 1967,369), avoid the ‘horribly painful and incapacitating stings’ of scorpion fish that ‘literraly blanketed the sea floor’ (Bond 1993,101), and deal with the constant influx of achovies into the PTC. The PTC had to be raised from the ocean floor to rid it of the rotting fish making it once again habitable for the aquanauts. This in itself was a risky operation, the undersea life setting into motion a series of events that would see the men’s only safe haven in the event of an emergency temporarily removed from the seafloor. As Bear and Eden (2008) have highlighted, the seas’ natural inhabitants have agency, pushing against human domination and thus proving themselves worthy actors in any undersea terrain analysis.

Moving to the human body, the dark and cold water surrounding the aquanauts became part of one and the same operating environment as the mapped seafloor with significant corporeal effects. As Miller et al (1957,254) stated, the ‘ocean at 200ft is an unforgiving adversary.’ The cold 9-11 degrees Celsius water made operating for long periods of time difficult whilst the visibility, which ranged from 0-9m at best made navigation inherently dangerous. In addition to the cold and inability to see, the men’s ears (as was revealed afterwards) suffered from levels of acoustic trauma similar to those who have been exposed to loud noise for long periods of time (Miller et al 1967,265)[[1]](#footnote-1). Additionally the aquanauts’ suffered from ear infections, skin rashes were common, and stress levels were raised. In this all-encompassing underwater terrain, the ‘divers continually touch and are touched by water’ (Merchant 2011a:223). These embodied effects were not enacted on or by a flat grounded seafloor terrain. Rather, the men’s bodies were being worked on by a three-dimensional operating environment that was suspended in the watery molecules that surrounded them and interacted in a minute, physiological way with their bodies.

The water is also felt on the body because it weighs heavily. Pressure under the sea increases at a rate of 1 atmosphere for every ten metres of depth meaning that the aquanauts in Sealab II were living and working under 7 times greater pressure than land. As each atmospheric contour of ten metres is crossed, the body accrues what is known in diving as a decompression debt, created by an increased amount of gases dissolving in the divers’ cells as the pressure increases (Seedhouse 2010). Were they to simply begin their ascent back to the surface from the seafloor, the gases would leave solution, causing life threatening bubbles to develop in the bloodstream. The men were, as the Navy (1966) stated ‘inhabitants of the sea’ until they had decompressed for some 30 hours or more’, slowly ridding their bodies of pressurised gas at a rate of 1.8m per hour (Carpenter and Blockwick 1967,122). Once again, this is a terrain that is not rooted to terra; it is suspended in the volume of the sea, dictating the mobilities (and immobilities) of the aquanauts and impacting every interaction they have with the seafloor and body of water.

To compound these difficulties, breathing air with the same oxygen content as land at depths greater than 55m is toxic and nitrogen becomes narcotic. To combat this, the cells of the aquanauts had to be saturated with another form of air than that breathed on land. Helium provided the solution as it does not have the same narcotic properties at depth and the body’s cells would become fully saturated with air if helium formed the majority of the gas mixture (Seedhouse 2010). The men thus lived in and breathed an atmosphere consisting of 78% helium, 17% nitrogen, and 5% oxygen (Mazzone 1967,110). This was not without consequences for the human body. In a helium-rich atmosphere, the human body loses heat at an alarmingly high rate leaving the men, at times, sweating whilst feeling chilled (Bond 1993). Headaches and disrupted sleep were also common, and communication difficulties were experienced because of the high pitched quality of their voices. As Le Dû-Blayo (2014,127) highlights, the sea is never a passive background – people ‘walk across it, they experience it, and it is often tested with intense physical involvement’. This raises interesting questions when thinking about terrain beyond the terrestrial. For example, how might we consider the air as terrain as bodies move through regions of high altitude? One Everest climber, for example, describes how the thin air seemed to burn his ‘lungs like frozen fire’, he breathed, gasping like ‘like a wild animal in an attempt to devour the oxygen’ that seeped into his mask (Grylls 2011,402). Air, much like water, is pre-eminently apt as a means of surrounding, but also permeating, forming an intricate relationship with the body that is inseparable from any analysis of how the body moves in certain spaces. The burning air in this example becomes formative; it becomes part of terrain that is moved *through* rather than *across.*

If we return to Sealab, the contours of the multi-dimensional terrain were clearly wrapping themselves around and even inside the body - an intimate relationship between man and sea that the Navy only encouraged as they sought to ascertain ‘the limits on flesh and blood beneath the waves’ (US Navy 1966). For the medical scientists on the surface, including Dr Bond who acted as Senior Medical Officer (Murray 2005), the human body, not the ocean, became the terrain to be analysed, understood and mastered. The aquanauts were subject to a daily physiological program that looked ‘at nearly one hundred parameters of body function and states of health’ (Bond 1993,126). Measures of pulmonary function and exercise tolerance were taken, and ECGs and EKGs performed each day (Bond 1967,203). The task of taking samples of bodily fluids also became routine with 20 cubic cm of blood extracted from the aquanaut’s daily**.** They became subjects in this experimental ‘frontier engineering’ (Farish 2006), their bodies reduced to their inner workings, the skin a mere surface to cross as the Navy sought to map the molecular. The enzyme, the blood cell, the heartbeat, rather than sediment, sand or vegetation, became the units of analysis in this terrain and the subsequent lines of life mapped onto graphs became yet another contour in this cold war experiment. The body functioned as a space with its own geographies, its own rhythms, flows, and processes that needed to be charted and recorded in their three dimensional entirety if future engagements between military man and the sea were to be successful.

**Conclusion**

The Sealab endeavours were an extraordinary attempt by the US Navy to negotiate the undersea terrain. Efforts to capitalise on the successes of Sealab I and Sealab II continued with Sealab III but the third habitat experienced problems from start to finish, resulting in the tragic death of one of the aquanauts, and marking the end on the Sealab programs as attention turned from the seas to space (Billings 1997). Despite their end, the Sealab projects offer a rich and provocative site of intervention to explore the concept of terrain within geography, to re-think its relational aspects, re-root it from terra, and re-orientate it towards the body.

For the US Navy, inhabiting the sea involved engaging with a terrain that was not rooted to the seafloor. Far from being a relatively static geological construct on the earth’s crust, the voluminous terrain of the sea is dynamic, and inherently relational; it is full of non-human life, it weighs heavily, forcing oxygen out of the blood cells if not mixed with helium; it is cold, its matter working to obscure the vision of those who dwell within it. The seas’ mobilities, currents, ebbs and flows, must be understood; its atmospheres and pressures adapted to; its resident non-human bodies negotiated. The air saturating the body’s cells needs to be altered, and managed; the flesh and all contained within brought into contact with the strategic and mapped with lines representing the beat of the heart, the pressure of blood flowing through veins and arteries, and enzymes circulating through the bodily volume in the bloodstream if imaginative agendas for the colonisation of the sea were to be satisfied.

The experiences of the aquanauts during Sealab demonstrate that the sea is an inherently demanding operating environment for the body but it also places demands on our engagement with terrain as concept and practice. The sea terrain exists through complex and intricate relationships between seafloor, water, and body which in turn raises interesting questions about how this relational approach can be applied to other voluminous elemental environments. Air is a clear site in which this analysis can be further extended, not merely as a volume in and of itself, but as a substance that fills the lungs as bodies move through space. In an urban environment, this may too have purchase. In urban warfare, how does air facilitate or hinder certain strategies or manoeuvres? The wind for example, must be taken into account when firing weapons; dust may be suspended in air, hindering vision and interacting with light and high winds can interfere with flight (Adey et al 2011). We might also turn to other immersive spaces such as caves and tunnels where volume becomes important – where sound and light travels differently affecting how those spaces are negotiated. Questions around temporality also warrant further investigation. When we bring *terrain* into conversation with the earth’s volumes how do we grapple with its temporality, with moving air, tides, melting ice, temperature gradients, and the effects of night and day?

Pushing off from the seafloor, and the earth’s floors in general, and re-rooting terrain into the earth’s volumes provides a constructive means of stretching and enhancing our understanding of terrain as concept and practice within geography and beyond. Anything but a fixed object, terrains are mastered by militaries *in* the world’s volumes, not merely on them. Moreover, in thinking critically about terrain, rather than merely accepting it as a pre-condition of geography, opportunities are opened to explore other conditions of terrain. In this paper these conditions have been the elemental volumes within which the earth’s formations exist and the molecular, visceral bodily formations that must somehow alter and adapt to being removed from terra and immersed in an all-encompassing terrain, but there are no doubt many other opportunities for the unfolding and up-rooting of terrain within geography.

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1. See Straughan 2010 and Merchant 2011 for more on the effect of water on the body’s senses. [↑](#footnote-ref-1)