A Cabinet in the Clouds: J.A. de Luc, H.B. de Saussure and the Changing Perception of the High Alps, 1760-1810

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Contents

Abstract

Today, the perception of the Alps – and mountains in general - as an object or place of scientific and aesthetic value is an acknowledged element of Western culture. Before the eighteenth century, however, Europe possessed a markedly different mentality towards its mountain heart – one of fear and disdain toward the dangerous alpine desert. Yet the eighteenth century witnessed a reversal of this centuries-long prejudice as the cultivation of empirical methodology, coupled with the concomitant institutionalization of science and emergence of bourgeois culture paved the way for a transformation of Europe's alpine mentality. The pioneers of this change were Horace-Benedict de Saussure and Jean-André de Luc, natural philosophers of Swiss descent. Advocating meticulous observation, precision instrumentation and fieldwork, along with an implicit awareness of alpine aesthetics, Saussure and de Luc became the first to systematically study and appreciate the scientific and aesthetic value of the high Alps. Investigating the roles of Saussure and de Luc in transforming the perception of the Alps, this dissertation will focus on the core elements of their scientific methodology, demonstrating how the confluence of these components provided the catalytic force necessary to cast the Alps anew.

Abrégé

De nos jours, la façon de voir les Alpes et les montagnes en général, en tant qu'objet ou lieu qui a une valeur scientifique et esthétique, est tout à fait accepté par la Culture occidentale, Cependant, avant le XVIII ième siècle, l'Europe possédait une mentalité totalement différente à l'égard de son coeur montagnard, elle considérait ce désert alpin dangereux avec peur et mépris. Le XVIII ième siècle a vu un revirement de ce préjudice qui datait de centaines d'années. La culture de la méthodologie empirique à laquelle s'ajoutera l'institutionnalisation des Sciences et la naissance de la culture bourgeoise, ont ouvert la voie à une transformation de la mentalité alpine en Europe. Horace-Benedict de Saussure et Jean-André de Luc,tous deux physiciens d'origine Suisse, furent les pionniers de ce revirement. C'est en poussant à faire des observations méticuleuses, avec des instruments de précision et en faisant des recherches sur le terrain tout en ayant une sensibilisation absolue à propos des principes esthétiques alpins, c'est ainsi que Saussure et de Luc devinrent les premiers à en faire une étude systématique et à apprécier la valeur à la fois scientifique et esthétique des Hautes Alpes. Cette dissertation mettra l'accent sur les rôles de Saussure et de de Luc quant à la transformation de la perception des Alpes et se concentrera sur les éléments principaux de leur méthodologie scientifique, montrant comment la convergence de ces éléments fournit la force catalytique nécessaire pour présenter les Alpes dans un nouveau contexte.

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~~ Introduction ~~

"Congratulate me," Horace-Benedict de Saussure beseeched his Bernese friend Wyttenbach, "I come from the conquest of Mont Blanc."[1] Saussure's triumphant 1787 ascent invigorated Europe, and he was greeted with a victor's welcome on his return to Geneva. He had conquered the Alps' highest peak - or so history has documented his achievement. In fact, Jacques Balmat and Michel Paccard accomplished the first successful ascent of Mont Blanc the previous year, claiming Saussure's reward for the feat.[2] Rather, Saussure, in the name of science, opened the high Alps to European perception, glorifying a terrestrial phenomenon that had long been viewed with disdain and fear. Saussure's widely publicized feat, labeled the historian's "golden spike" by the eminent historian of geology Martin Rudwick, served as a marker for a new period of geohistory, alpine aesthetics, and eventually, the golden age of nineteenth century mountaineering.[3] However, the ascents of Mont Blanc were not the first in western European history. Isolated individuals had done so in previous centuries, perhaps none more prominent than Petrarch's fourteenth century spiritual ascent of Mont Ventoux,[4] or Leonardo da Vinci's scientific and alpine pursuits. The respect and significance bestowed

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[1] Douglas William Freshfield, *The Life of Horace Benedict de Saussure* (London: E. Arnold, 1920), 235. Saussure travelled extensively throughout the entire range of the Alps – which stretch from Austria and Slovenia in the east through Germany, Switzerland and France in the west – but his expeditions focused on the mountains surrounding Geneva and those of the Savoy (an independent duchy for much of the last millennium until the eighteenth and nineteenth centuries when it was acquired by France).

[2] In the light of additional evidence recovered in the twentieth century, even this chronology appears suspect. The motivations and accounts of another alpinist, Marc-Theodore Bourrit, have muddled the historical record and forced scholars to reconsider the chronology and attribution of the feat. A prolific writer and a chief cause of the popularization of the Alps, Bourrit is often called the "Historian of the Alps." See Fergus Fleming, *Killing Dragons: The Conquest of the Alps* (New York: Atlantic Monthly Press, 2000).

[3] Martin J.S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2005), 22.

[4] Though in Provence – and often considered separate from the Alps – Mont Ventoux is geographically part of the Alps. Petrarch's ascent, spiritual and not scientific in intent, is nonetheless a watershed event in the history of the Alps.

upon these individuals in historical discourse does much to elucidate their value to the intellectual progress of Europe, but the fact remains that such "alpinists" represented an exception to the rule; few, if any, ventured off the beaten path.[5]

Until the eighteenth century, the perception of the Alps was typically negative as travel discourse characterized the mountains as agriculturally intractable, aesthetically repulsive – a blemish on the face of the earth - and dangerous masses that offered the traveler nothing but distress.[6] European culture and science was bereft of the tools and intellectual climate – the prevalence of a bourgeois culture, the popularization and institutionalization of science, and the epistemological change from "abstract rationalism to experimental philosophy" - needed to approach the Alps with either aesthetic appreciation or scientific objectivity.[7] Yet it was the intellectual developments of the early and mid-Enlightenment, which paradoxically perpetuated the *status quo* of alpine perception, that paved the way for change. The socio-cultural impetus for colonial knowledge inspired exotic scientific expeditions while economic incentives encouraged the study of mineralogy and geognosy in Europe's mining regions.[8] With natural knowledge a vehicle for public enlightenment, the proliferation of academic journals

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[5] Walter Woodburn Hyde, "The Alps in History," *Proceedings of the American Philosophical Society* 75, no. 6 (1935), 436. Hyde relates the discovery of fifty-four coins, dating from the Roman Empire, in an alpine pass that was never used for transportation either in ancient or modern times. This suggests that merchants or smugglers did, in isolated instances, venture into the Alps' more remote regions.

[6] Robert Macfarlane, *Mountains of the Mind* (New York: Pantheon Books, 2003), 15; Charlotte Klonk, "Science, Art, and the Representations of the Natural World," in *The Cambridge History of Science: Volume 4 – Eighteenth Century Science*, ed. Roy Porter (Cambridge: Cambridge University Press, 2003), 586.

[7] Jacques Roger, "The Living World," in *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*, eds. G. S Rousseau and Roy Porter (Cambridge: Cambridge University Press, 1980), 264.

[8] In the eighteenth century, there were four distinct sciences concerned with terrestrial phenomena: mineralogy, physical geography, geognosy and earth physics; the first three, focusing on natural history, described and classified. The differences are succinctly summarized by Rudwick (*Bursting the Limits of Time*, 99): "Mineralogy was a science of specimens, practiced primarily indoors in museums; physical geography was a science of spatial distributions, based on outdoor fieldwork; and geognosy was a science of three-dimensional structures, also based on fieldwork but exploiting additionally the dimension of depth that was revealed by the practice of mining." The last, earth physics, was the study of physical causes in the natural world, using the other three as raw material.

provided an additional source for the dissemination of scientific developments.[9] These, coupled with an ardent attack by late-Enlightenment natural philosophers upon the perceived weaknesses of the dominant mechanistic paradigm, led to the development of a new experimental methodology for pursuing science. Though this wholesale change was not his brainchild, Saussure nonetheless functioned as its catalyst in the realm of alpine science, representing a new breed of natural philosopher. More important, he was not alone in his quest for alpine knowledge: Saussure's Swiss compatriot Jean-André de Luc, an individual unfortunately reviled in the historical record and sometime adversary of Saussure, likewise featured front and centre in transforming the Alps into objects of science.

All too often, however, historical discourse offers the reader little more than this rather simplistic analysis of the role of alpine science in changing the perception of the Alps.[10] Historians of eighteenth century science and empire have focused their study on contemporary travelers – either scientific or otherwise – who engaged in maritime expeditions to the exotic regions of the globe. Contemporary accounts emphasizing sea voyages certainly promoted European consumption of empire, but in focusing upon the

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[9] James McClellan, "Scientific Institutions and the Organization of Science," in *The Cambridge History of Science: Volume 4 – Eighteenth Century Science*, ed. Roy Porter (Cambridge: Cambridge University Press, 2003), 95.

[10] The term "alpine science" will refer to the breadth of science conducted in the mountains, utilizing disciplines ranging from botany, geology, chemistry, physics and meteorology – although the accumulation of geological and meteorological measurements and observations became the focus of Saussure and de Luc. Using innovative techniques and instruments – such as the barometer, hygrometer, thermometer, cyanometer, and more – both explored the relationship between humidity, atmospheric pressure, snow and tree-line, temperature, altitude, evaporation and the composition of air. For example, altimetry using the barometer could occur only after the relationship between altitude and atmospheric pressure had been elucidated; or, recognizing the relationship between altitude and temperature in an enclosed space, Saussure used the heliothermometer to demonstrate the increase of solar radiation at altitude; a comparison of tree-line in the Alps and the Andes proved to Saussure that temperature and not air density limited alpine vegetation growth. See R.G. Barry, "H.B. Saussure: The First Mountain Meteorologist," *Bulletin of the American Meteorological Society* 59, No. 6 (1978).

periphery, Europe's continental centre was ignored.[11] Where continental expeditions have been analyzed to the same extent, historians typically focus on Alexander von Humboldt's journey through South America. Continental Europe, especially the Alps, appears to offer a subject of less intrinsic interest to the historian of scientific travel. Recent scholarship in the history of geology has certainly emphasized individuals fundamental to alpine science, but the motivation of such scholars is the assessment of specific scientific elements; understandably, there is little interest to examine the role of natural philosophers in changing the perception of the Alps. At the same time, the significance of past geologists is hindered by a "Lyellian myopia" that devalues his predecessors.[12] The acknowledgment of this serves the historian well, for the contribution of a de Luc or Saussure can henceforth be illuminated.

Moreover, the approach of many dated histories is often Marxist, their authors highlighting German science in the mining regions of the Saxon Ore Mountains and revealing the role of its leading practitioners, Leopold von Buch, Abraham Gottlob Werner and the Mining Academy of Freiberg; French and English historians have likewise investigated individuals dear to them, all the while ignoring the role of Swiss science.[13] The various works expounding such views relate the history of ores, oil and coal as essential to understanding the (economic) connection between the physical world and humanity.[14] Where the mountains are considered, credit is bestowed upon Humboldt

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[11] David Philip Miller, "Introduction," in *Visions of Empire: Voyages, Botany, and Representations of Nature*, eds. David Philip Miller and Peter Hans Reill (Cambridge: Cambridge University Press, 1996), 3.
[12] R.H. Dott, "James Hutton and the Concept of a Dynamic Earth," in *Toward a History of Geology*, ed. Cecil Schneer (Cambridge: MIT Press, 1969), 122.
[13] Roy Porter, *The Making of Geology: Earth Science in Britain, 1660-1815* (Cambridge: Cambridge University Press, 1977), 206. Porter notes that it was easier to banish theories when they came from either Swiss or Scottish natural philosophers.
[14] H.H. Read, *Geology, an Introduction to Earth-History* (London: Oxford University Press, 1949),1; Frank Dawson Adams, *The Birth and Development of the Geological Sciences* (Baltimore: The William &

– who not coincidentally had affiliations with the Mining Academy – for shaping alpine geology.[15]

If historians of science have shown little curiosity in elucidating the role of science in "opening the Alps," at least their literary colleagues have taken a greater interest. Indeed a wealth of scholarship has concentrated on Jean-Jacques Rousseau and the subsequent Romantic poets and artists, Wordsworth, Byron, Shelley and Turner.[16] The Romantic period strengthened Europe's new "alpine mentality," but the shift was ultimately a *fait accompli*. Conversely, if any single individual is credited with changing Europe's opinion of mountains and the Alps in particular, it is generally Rousseau. Acknowledging the role of Saussure, Stephen Leslie nonetheless asserted that "If Rousseau were tried for the crime of setting up mountains as objects of human worship, he would be convicted by any impartial jury. He was aided, it is true, by accomplices, none of whom were more conspicuous than Saussure."[17] Rousseau was the "Columbus of the Alps," instituting regular worship of them, an opinion that Chateaubriand explicitly endorsed. Notwithstanding his "mountain glory," however, Rousseau's alpine interest consisted only of the low and mid Alps; even he considered the high Alps barren.[18]

Following the heyday of European mountaineering in the latter half of the nineteenth century, the historians Leslie Stephen, Gavin de Beer and Arnold Lunn, all members of the British Alpine Club, wrote extensively on the history of the Swiss Alps, elucidating their "opening," geography, and various recreational ascents of the nineteenth

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Wilkins Company, 1938), 210.
[15] Hans Baumgärtel, "Alexander von Humboldt: Remarks on the Meaning of Hypothesis in his Geological Researches," in *Toward a History of Geology*, ed. Cecil Schneer (Cambridge: MIT Press, 1969), 20.
[16] For an examination of "rocks" as an essential element of both romantic science and literature, see Noah Heringman, *Romantic Rocks, Aesthetic Geology* (Ithaca: Cornell University Press, 2004).
[17] Leslie Stephen, *The Playground of Europe* (London: Longmans Green and Co., 1871), 38.
[18] Ibid., 7.

century. Although their numerous works present a vast wealth of knowledge, the focus is entirely narrative; recent accounts of the conquest of the Alps are typically plagued by similar concerns. Such discourse reads as a narrative biography of Saussure and subsequent alpinists, emphasizing the geography of their routes and a description of the ascents.

Providing undeniable historical value and engaging stories, the majority of scientific, literary or historical works written in the English[19] language offer little analysis regarding how and why science transformed the negative perception of the *high* Alps during the latter half of the eighteenth century, instilling a love of alpine science and aesthetics. Each certainly imparts useful knowledge. However, a synthesis of the relevant elements has yet to be carried out in any extensive manner. As Saussure's aforementioned ascent suggests, the impetus for observing and understanding the high Alps was ultimately scientific. Sublime aesthetics, recreation and health surely offered the traveler reasons for visiting the Alps, but these were insufficient to sanction a wholesale acceptance of the still barren and dangerous peaks; a catalyst was required. Thus, the principal question is what elements of late-Enlightenment physical science were responsible for changing the perception of the high Alps from a cruel wasteland to a sublime Mecca valued by science and literature for its natural phenomena and ability to move the soul?

To further focus the argument, this dissertation will consider Saussure and de Luc the primary catalysts for this change. This objective is two-fold. More than simply elucidating the transformation of the high Alps from a cruel wasteland to an object valued by science and aesthetics, I will investigate the scientific methodology and achievements

[19] The source material of this dissertation will center almost exclusively on works available in English.

of these understudied individuals. Though hailed in their day (Saussure certainly more so than de Luc) as harbingers of meteorology – and at times geology – historians have been either reluctant or uninterested to engage in an extensive study of these men and their importance to science. Certainly Saussure is still recognized as the victor of Mont Blanc, but few venture to analyze his import any further. Where de Luc and Saussure enter the historical record, especially in the history of geology and meteorology, history emphasizes the accuracy –and often erroneous nature - of their science rather than their role in transforming the Alps and perceiving the in the mountains a panacea for questions long confounding natural philosophy. Given de Luc's physicotheology, it is unsurprising that the historian concerned only with the development of the one true geological system would ridicule de Luc's geology, despite his advocacy of what would ultimately lead to modern fieldwork. Dichotomizing science and religion, historians of science have been typically incapable of respecting and intelligently analyzing the religious beliefs of past cultures.[20]

Instead, historians applaud a Hutton or Lyell as the pioneers of modern geology for the veracity of their work; a brief meta-analysis of geological textbooks emphasizes their historical status. It is not the intention of this dissertation to undermine such adulation, but rather to acknowledge the roles of de Luc and Saussure, even though various aspects of their science *were* in hindsight erroneous. De Luc, for instance, represents a paradoxical and enigmatic historical figure: despite endorsing a dying breed of physicotheology, he was at the forefront of late-Enlightenment methodological developments in science; and despite severe criticism from historians of science, he was

[20] Martin Rudwick, "The Shape and Meaning of Earth History," in *The New Science of Geology: Studies in the Earth Sciences in the Age of Revolution* (Aldershot: Ashgate, 2004), 297.

revered by many in his time and shortly after. Regardless of any scientific error or naivety, de Luc and Saussure deserve further study for no other reason than the competitive environment their theories and observations gave rise to. Forcing colleagues to provide ever more accurate evidence to substantiate and develop their respective theories, the ensuing agonistic environment expanded the bounds of science. Moreover, not only did collective work lead to increasing objectivity and standardization, but the struggle to surpass one's colleagues amplified alpine travel as natural philosophers sought new or more accurate evidence.[21]

In discussing the role of de Luc and Saussure in opening the high Alps, the themes of scientific travel or fieldwork, precision and instrumentation, and the sublime will form the core of the analysis. Though neither de Luc nor Saussure introduced any of these elements to late-Enlightenment science, both were the first to *meaningfully* and *systematically* incorporate them into alpine science and its methodology. Fieldwork as a scientific idea possessed an extensive lineage, but few extolled or understood its value until the mid-eighteenth century; armchair science took precedence over the debasement of fieldwork. Precision and quantification developed as a response to the unfounded speculation of such armchair science, with an emphasis on standardization and instrumentation. Standardization functioned as an essential element of precision instrumentation since it allowed, for the first time, collaboration, corroboration, and comparison, all of which ushered in an era of decontextualized knowledge. The sublime, however, formed a rather controversial aspect of de Luc and Saussure's work. The high Alps inspired both, and their works abound with aesthetic judgments, but each likewise

[21] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America, During the Years 1799-1804*, Vol. 1 (London: H.G. Bohn, 1852), 90.

asserted that the subjective must not play a role in true science. To illustrate the continuation of de Luc and Saussure's methodology and alpine science, these themes will be examined with regard to the behemoth of early nineteenth century science, Alexander von Humboldt, with the goal of positing de Luc and Saussure's trailblazing value to science. Ultimately tendering an explicit challenge to Enlightenment mechanism, de Luc and Saussure sought to dismantle the prevailing paradigm. Their work, coupled with that of their colleagues, instigated a change from speculative theory to precision observation and quantification, from armchair science in cabinets of curiosity to the examination of immovable and whole phenomena, and from the study of the curious or anomalous to the common.

Horace-Benedict Saussure and Jean-André de Luc

Saussure, praised throughout Europe for his four volume *Voyages dans les Alpes*, was born at Conches, near Geneva, in 1740 to an influential family.[22] Until roughly 1765, the countryside remained his home, offering the opportunity to observe the Alps firsthand, a desire that never escaped him. Exploring the Jura, Saussure remarked that "these relatively low mountains could only imperfectly satisfy my curiosity. I was burning with the desire to see close at hand the High Alps."[23] Even by the age of nineteen, his friend Jean Senebier could remark that Saussure's work was "remarkable for precision of thought, clearness of style, and accuracy in excluding all hypothetical matter."[24] With the

[22] For a complete biography of Saussure's life and travels, see Douglas Freshfield; it is the only work in the English language devoted to the life of Saussure. It is unfortunate, and informative, as Freshfield remarked about his work, that "the following pages represent an endeavor to fill an obvious gap in Alpine literature. After more than a century, Horace Benedict de Saussure still awaits his biographer."
[23] Horace-Benedict de Saussure, ''*Discourse Préliminaire*,'' in *Voyages dans les Alpes, Précédés d'un Essai sur l'Histoire Naturelle des Environs de Genève* (Neuchâtel: Samuel Fauche, 1779).
[24] Freshfield, 60.

support of the influential Albrecht von Haller and Charles Bonnet, Saussure continued his academic development, first visiting Chamonix in 1760 to collect plants for Haller. Two years later, with Haller's recommendation, Saussure was granted a prestigious professorship in philosophy at the Academy in Geneva. Despite his teaching duties, the Alps remained at the forefront of his work, with his principal travels taking place between 1774 and 1789.

Since his historic ascent over two centuries ago, history has obscured the majority of Saussure's further achievements. Historians of geology and meteorology have at times conferred great praise for his pioneering work in alpine science, but all too often, he is simply known as the conqueror of Mont Blanc. Saussure's colleagues, however, frequently extolled the value of his *Voyages* and science's debt for his invention of the cyanometer, diaphanometer, hair hygrometer and the anemometer.[25] Even Charles Lyell, so critical of de Luc's physicotheology, offered Saussure high praise for his alpine observations.[26] Humboldt likewise makes frequent reference to the *Voyages*, and Saussure appears on the engraving to Humboldt's *Physical Portrait of the Tropics*. Standing victoriously atop Mont Blanc, Saussure faces Humboldt, standing atop Chimborazo, the Alps a reflection of the Andes, and empirical science the bond between Saussure and Humboldt.[27]

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[25] A.P. de Candolle, "Biographical Memoirs of M. de Saussure," *Philosophical Magazine* 4 (1799), 100. The cyanometer was an instrument that measured the intensity of the sky – which becomes darker at altitude – by using a colour spectrum of shades of blue (16 shades were first used on Mont Blanc in 1787, while 51 were later used); the diaphanometer was used to judge the transparency of the atmosphere; the anemometer measured the velocity of the wind and the hygrometer measured humidity.

[26] Charles Lyell, *Principles of Geology, or, the Modern Changes of the Earth and Its Inhabitants Considered as Illustrative of Geology* (New York: Appleton, 1857), 223.

[27] Michael Dettelbach, "Global Physics and Aesthetic Empire: Humboldt's Physical Portrait of the Tropics," in *Visions of Empire: Voyages, Botany, and Representations of Nature*, eds. David Philip Miller and Peter Hans Reill (Cambridge: Cambridge University Press, 1996), 284.

In the early twentieth century, Archibald Geikie and Frank Dawson Adams, pioneers in the history of geology, touted Saussure as one of the principal representatives of alpine science, though each recognized that Saussure did not offer geology much correct knowledge regarding the origin of the Alps.[28] Geikie criticizes the laborious task of sifting through the *Voyages*, and the lack of informative images, yet he argues that it was in fact Saussure who finally surmounted alpine prejudice, marking the beginning of experimental geology. "But his name [Saussure]," Geikie insists, "must ever be had in honour for the share he took in establishing the use of direct experiment in the elucidation of geological problems."[29] Geikie and Adams, despite their veneration of Saussure's role in opening the high Alps, nonetheless perpetuated the prevailing attitude towards him, which has seen his methodology briefly admired, but largely understudied.

If Saussure is characterized as the Alps' hero, Jean-André de Luc is usually depicted as his nefarious colleague and James Hutton's dogmatic assailant. Born in Geneva in 1727, the son of a politically and religiously active watchmaker, de Luc inherited his father's principles and along the way developed a keen interest in natural philosophy. Where Saussure befriended Albrecht von Haller, Jean-Jacques Rousseau served as a mentor for de Luc, proffering his student literary advice and a passion for the mountains.[30] Notwithstanding Saussure's ascent of Europe's highest peak, mountaineering in Savoy arguably began with de Luc's annual explorations around Faucigny starting in 1744, and his attempted ascent of Mont Buet with his brother Guillaume-Antoine in 1765.[31] Initially unsuccessful, the brothers achieved their goal five

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[28] Adams, 387-91.
[29] Sir Archibald Geikie, *The Founders of Geology* (London: Macmillan and Co., 1905), 190.
[30] Paul Tunbridge, "Jean-André de Luc, F.R.S.," *Notes and Records of the Royal Society of London* 26, no.1 (1971), 15.
[31] Freshfield, 175.

years later, and their time on the summit offered the opportunity to complete various barometrical experiments. De Luc's *Recherches sur les modifications de l'atmosphère* (1772), which revealed his search for accurate barometrical measurements of mountain heights, is often cited as his most influential treatise. Following a second ascent of the Buet two year later, a failing business (which occupied his first forty-six years) and political instability with France forced de Luc to emigrate to England in 1773. Here, conferred with candidature to the Royal Society, de Luc embarked on his long-time position as reader to Queen Charlotte at Windsor.[32] Until his death in 1817 he served as the Queen's reader, presenting him with the income and time to pursue scientific pursuits that saw him travel throughout western Europe and devote much time to the development of accurate meteorological instruments.

Historiography, however, has been largely unkind to de Luc. Historians of geology have, over the past few decades, increasingly commented upon his role in late-Enlightenment science, but the literature is generally injurious; leading the charge are Martin Rudwick and Roy Porter, though Rudwick's research is far more considerate of de Luc's value. Conversely, Porter paints a rather sordid picture. For Porter, de Luc was "extraneous to the empirical temper of the age," a physicotheologist destined for extinction and a prime cause of the war between divinity and geology that plagued the nineteenth century.[33] Nor is Porter alone in his assessment. Where Geikie praised Saussure, he suggested that although de Luc (and the physicotheologist Richard Kirwin) "wielded great influence in their day, their writings have fallen into deserved oblivion.

[32] With the collapse of the first Coalition against France, de Luc was recruited by the British government to serve as an envoy on a secret mission to the Duke of Brunswick, in an attempt to reach Frederick William of Prussia. To do so, de Luc obtained an honorary professorship in geology and philosophy at the University of Göttingen.
[33] Porter, *The Making of Geology,* 165, 202.

They are never read save by the curious student, who has leisure and inclination to dig among the cemeteries of geological literature."[34] And though de Luc's peers often supported him, Lyell likewise lashed out against his physicotheology:

> If speculations so vague and visionary can be proposed concerning natural operations now passing before our eyes – if authors may thus dogmatize, with impunity, on subjects capable of being determined with considerable degree of precision, can we be surprised that they who reason on the more obscure phenomena of remote ages, should wander in a maze of error and inconsistency?[35]

As Klaver demonstrates, Lyell used de Luc's dogmatism to categorize geologists he deemed had gone too far towards Mosaic geology.[36] Moreover, much of de Luc's negative reputation stems beyond his advocation of Mosaic history. His very public controversies with Hutton, Saussure, Lavoisier and Joseph Black did much to damage his reputation. Not to be outdone by peer or historical criticism, the political landscape of the eighteenth century, namely in France, undermined physicotheology and its proponents by asserting its inadequacy in explaining natural phenomena. Where Protestant culture tolerated the pious naturalist, French empiricism appeared to be unable to conceal the religious overtones that permeated their science.[37]

Many of de Luc's detractors argue few, if any eminent geologists adopted his theories. Certainly his meteorology was far better received than his Mosaic geology, but his views *did* garner support both during and after his life. Whether in part or whole,

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[34] Geikie, 330.
[35] Quoted in J.M. Klaver, *Geology and Religious Sentiment: The Effect of Geological Discoveries on English Society and Literature between 1829 and 1859* (Leiden: Brill, 1997), 41.
[36] Lyell was not alone in this respect. John Fleming's review of George Bellas Greenough's *A Critical Examination of the First Principles of Geology* (John Fleming, Review of Greenough's *Critical Examination*, Edinburgh Monthly Review, IV (1820), 571) recalls de Luc's dispute with John Playfair as an analogy for poor scientific work.
[37] Dennis R. Dean, *James Hutton and the History of Geology* (Ithaca: Cornell University Press, 1992), 19; Rudwick, *Bursting the Limits of Time*, 367; Steven Shapin, "The Image of the Man of Science," in *The Cambridge History of Science: Volume 4 – Eighteenth Century Science*, ed. Roy Porter (Cambridge: Cambridge University Press, 2003), 162.

Lavoisier, Dolomieu, Cuvier, and Sir John Pringle (president of the Royal Society, 1772-78) all endorsed *elements* of his work; and as late as 1847, William Whewell advocated the accuracy of de Luc's *Elementary Treatise on Geology* (1809) over Hutton and Playfair.[38] Assessing de Luc's work in electricity, B.M. Forster emphasized de Luc's value to science:

> I consider the invention of this column [de Luc's electric column] as the most important discovery in the science of electricity since that of the *Voltaic pile*, and do not doubt that when Mr. De Luc gives his paper to the public, it will prove extremely interesting, and I have reason to believe it may lead to further discoveries which will be considered as very important in this branch of science.[39]

The *Philosophical Magazine*, observing his death, offered de Luc high praise for extending the limits of geology, the gentleness of his manners, and the results of his researches, for which he had been "unremittingly prosecuted for upwards of fifty years."[40] Whether an act of artificial empathy or not, the magazine placed him among the most distinguished philosophers of his age. Ultimately, as Charles Coulston Gillispie notes, "[de Luc's] writings give the impression that he was a likeable person, and they have the effect of making the reader regret that Deluc [sic] felt impelled to work so hard at unpromising projects. It seems unfortunate that he did not allow his reputation to rest upon his good investigations in electricity, chemistry, and meteorology."[41] De Luc, despite asserting otherwise, did naively put religion before science, but his value to late-Enlightenment science must not be arbitrarily belittled, and his role in changing centuries-long alpine prejudices is of the first order.

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[38] Georges Cuvier, *Essay on the Theory of the Earth* (Edinburgh: W. Blackwood, 1817), 148; Dean, 243.
[39] B.M. Forster, "Description of a Method of Fitting in a Portable Form the Electric Column Lately Invented by J.A. de Luc, Esq. Also an Account of Several Experiments Made with it," *Philosophical Transactions* 35 (1810), 209.
[40] Alexander Tilloch, "De Luc, the Geologist," *Philosophical Transactions* 50 (1817), 393.
[41] Charles Coulston Gillispie, *Genesis and Geology: A Study in the Relations of Scientific Thought, Natural Theology, and Social Opinion in Great Britain, 1790-1850* (Cambridge: Harvard University Press, 1951), 57.

Alpine Perception in Western Civilization: A Brief History

Throughout history, the Alps have functioned as an essential element in Europe's physical, cultural, political and economic landscape. Until the eighteenth century, however, the perception of the Alps remained mystical and foreboding. The first prehistoric or Paleolithic tribes settled the alpine lakes and valleys following the retreat of the ice sheets, inhabiting the mountains until Celtic tribes forced their dispersion around 1000 B.C.[42] Known to Herodotus and Aristotle, the Alps' initial notoriety stemmed from the Celts' mineral wealth and Hannibal's extraordinary pachyderm crossing in the Second Punic War.[43] The perception of the Alps fluctuated over the following two millennia, but what must be acknowledged is that this perception of the mountains remained bleak and uncertain; alpine glory was the exception, not the rule.

Description of the natural world, and in particular the mountains, was not unknown to the Greeks, although its role was relegated to that of merely a scenic backdrop in a human driven environment. The Greeks developed a dual perspective in acknowledging the mountains, but early descriptions, and indeed mountain names, often reflected wild or terrifying feelings of dread.[44] Mountains like Olympus were to be places of worship and temples, not literary description.

Herodotus, on the other hand, relays a common belief (albeit founded on tales and hearsay) that survived until the early eighteenth century, that various mystical monsters and people inhabited the mountains north and west of Greece:

> He [Aristeas] tells us that 'inspired by Pheobus' he journeyed to the country of the Issedones, and that beyond the Issedones live the one-eyed

[42] Andrew Beattie, *The Alps: A Cultural History* (Oxford: Oxford University Press, 2006), 25.
[43] Hyde, 432.
[44] Marjorie Hope Nicolson, *Mountain Gloom and Mountain Glory: The Development of the Aesthetics of the Infinite* (New York: Norton, 1963), 38.

> Arimaspians, and beyond them the griffins….Beyond the Argippaei, however, lies a region of which no one can give an accurate account, for further progress is barred by a lofty and impassable range of mountains…inhabited by a goat-footed race, beyond which, still further north, are men who sleep for six months in a year.[45]

Early modern dissertations offered far more scientific accounts, incorporating vivid illustrations, but this mystical foreboding shadowed the Alps from Greek times until the eighteenth century.[46] But cognizant of the protection mountains offered alpine tribes, the Greeks nonetheless valued, or at least recognized the practical function of 'lofty' peaks and thickly wooded forests, a characteristic emphasized to a much greater degree by the Romans.

The Roman attitude towards the Alps, and nature in general, was typically aloof and utilitarian, evoking no aesthetic response. Attracted to the Celts' mineral wealth, the mountains continued to elicit a negative response. The conquest of the alpine tribes and passes acquired a purely functional significance in the consolidation of the Republic and Empire, yet traveling statesmen on their way to Gaul openly cursed the passes and roads for the dangerous conditions they encountered. Ever warlike, Caesar assessed the Alps' function as both a natural barrier thwarting Helvetic and Roman conquest and as infertile land not suited for occupation. [47] Caesar insisted that even the Helvetii, the most prominent alpine tribe, found the Alps too unsuitable to establish a strong political jurisdiction over neighboring tribes. To ensure the protection of their interests in the region, the Romans still sought to control and conquer the tribes and passes. Nonetheless, there is little or no evidence to argue that the Romans felt anything but pervasive

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[45] Herodotus, *The Histories,* Trans. Aubrey de Sélincourt, 1954 (Harmondsworth: Penguin Books, 1972), IV, 13-25.
[46] Gavin de Beer, *Early Travelers in the Alps* (London: Sidgwick & Jackson, 1930), 76.
[47] Julius Caesar and Rex Warner, *War Commentaries of Caesar* (New York: New American Library, 1960), 25

animosity towards the mountains. This aversion to the Alps was coupled with a longing for the plains and sun of Italy:

> For Caesar shrugged off all delay. Desire
> For vengeance urged him on; abandoning
> The war in Gaul, he embarked on civil strife.
> Amidst the Alps' high peaks, where cliffs descend
> (The Greek god trod them down so men can pass),
> There lies the sanctuary of Hercules, enclosed
> By winter's frozen snow, its hoary peak
> Out-jutting to the stars. From there the sky
> Seems to have plunged below; no sun's hot rays,
> No Warming breeze of spring can soften it.
> Ice and the wintry frost maintain their hold.
> On its fierce shoulders the whole world can rest.
> When Caesar with exultant forces trod
> These heights, he chose this lofty-mountain peak
> From which he could discern outspread below
> The Plains of Italy.[48]

Petronius' description reflects the Roman perspective: despite faint hints, much like the Greeks, that supernatural beings inhabited unknown regions of the mountains, the perpetual alpine winter remains the fundamental characteristic of the Alps.

Notwithstanding differences between pagan and Christian traditions, the medieval attitude retained much of the Roman, concentrating on functionality rather than aesthetics. Among the French and English kings, traders, crusaders and pilgrims, the Alps remained an inevitable evil to be crossed on the path to Rome and the Near East. While the mountains did not acquire any real aesthetic value, both the Christian and pagan tribes added their own unique properties to Europe's alpine mentality. Saint Augustine, expressing early Christian sentiment, asserted that admiring the natural beauty of the world, especially that of the mountains, led to the forgetfulness of God and the risk of

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[48] Petronius Arbiter and P. G. Walsh, *The Satyricon* (Oxford: Oxford University Press, 1999), 122 (173-188).

damnation.[49] On the other hand, pagan discourse emphasized the supernatural not through eternal suffering, but a plethora of legends depicting evil spirits and dragons. Passed down orally and codified into mythico-historical tradition, these legends were local in nature and served specific moral functions. Indeed, the number of alpine legends is argued to be in the thousands, with five-hundred and forty in the Valle d'Aosta alone![50] One such tale alludes to the creation of the infamous Devil's Bridge, spanning the Schöllenberg Gorge between the St. Gotthard Pass and Lake Lucerne. Unable to build a bridge to access Italy, the Swiss consorted to negotiations with the Devil to construct the bridge.[51] These attitudes towards otherworldly fear prevailed throughout the Middle Ages, suppressing any intrinsic interest in the Alps. Where mountain peaks did inspire, proximity to heaven or spirituality, not innate physicality remained the dominant trope as Simon Schama relates: "In the late medieval imagination, then, the high mountain slopes were imagined as a cold-wreathed borderland between the physical and the spiritual universe. Arbitration was necessarily made in favour of the latter…because no one did any actual climbing."[52]

Certainly isolated instances occurred where individuals, motivated by practical or religious incentives, sought to ascend the mountains, but these attempts typically either failed or resulted in vindictive descriptions. Canterbury monk John de Bremble's 1188 journey over the St. Bernard pass is often cited as such an example. Bremble's comments acerbically reflected his experience: "Lord, restore me to my brethren that I may tell them

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[49] Kirchner, 417-18.
[50] Nicholas Shoumatoff and Nina Shoumatoff, *The Alps: Europe's Mountain Heart* (Ann Arbor: University of Michigan Press, 2001), 138.
[51] Ibid., 141.
[52] Simon Schama, *Landscape and Memory* (Toronto: Vintage Canada, 1996), 417.

that they come not to this place of torment."[53] The difficulty the alpine roads and passes presented to travelers was ultimately an insurmountable obstacle to humanity's perception of the Alps. Europeans were fundamentally unable to perceive value from the alpine world, a paradigm that would take centuries to chisel away.

As the waning medieval ideology ceded to the classical resurgence of the Renaissance, so too did its alpine ideology give way to humanism and its preeminent scholar, Francesco Petrarca. Considered the 'father of alpinism', Petrarch's ascent of Mont Ventoux in 1336 marks the first recorded achievement of its kind, dichotomizing European standards of perception.[54] Of course, Petrarch's actions were not typical of his day. Nonetheless, Petrarch remains a segue between medieval and modern attitudes.[55] Undertaken as an act of devotion to Laura, a woman he pines for in his poetry, Petrarch regarded his ascent as a 'voyage of the soul' in devotion to her. Reflecting upon his (anachronistically sublime) experience, Petrarch was "smitten by an unfamiliar wind and by the vastness of the spectacle."[56] Opening Augustine's *Confessions* on the summit, however, even Petrarch was not immune from its metaphysical indoctrination:

> [I] closed the book, angry with myself for not ceasing to admire things of the earth, instead of remembering that the human soul is beyond comparison the subject for admiration. Once again, as I descended, I gazed back, and the lofty summit of the mountain seemed to me scarcely a cubit high, compared to the sublime dignity of man.[57]

In what was an agonizingly slow process towards the appreciation of the Alps, the fifteenth through seventeenth centuries elicited much the same response. With little *a*

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[53] Ibid., 421.
[54] Jesús Carrillo, "From Mt Ventoux to Mt Masaya: The Rise and Fall of Subjectivity in Early Modern Travel Narrative," in *Voyages and Visions: Towards a Cultural History of Travel*, eds. Jaś Elsner and Joan-Pau Rubiés (London: Reaktion Books, 1999), 60.
[55] Schama, 419; Kirchner, 422.
[56] Shoumatoff and Shoumatoff, 189.
[57] Petrarch, quoted in Nicolson, 50.

priori or true knowledge of remote alpine regions circling Europe, travelers often resorted to crude metaphor to express their experience. Thus it was not without precedent that Sebastian Munster, in 1545, could compare the declivity of the Gemmi pass to the coil of a snail-shell, or that Richard Lassels (1637) or Bishop Gilbert Burnet (1685) depicted the Simplon as a staircase.[58] Perhaps the most common analogy, especially in an age of ocean travel and New World colonies, was that of the sea. Fellow French travelers Joachim du Bellay and Olivier de Magny, crossing the Grisons in 1556-7, professed it to be worse than a month long storm at sea; Maximillian Mission (1688) concurred that "the alpine summits covered with snow merge into the clouds and resemble the foaming waves of an angry sea."[59]

A change was afoot, however. The majority of alpine travelers continued to emphasize the Alps' wretchedness, but the mere fact that a greater number of travelers actively acknowledged either the positive or negative elements of the Alps was crucial. Few, if any, ventured off the beaten path, but increasing numbers began to see value in the mountains, choosing to venture amongst the peaks for exercise, health, or the pleasant charm of wooded slopes and pastures. Preempting eighteenth century literature, even landscape painters joined the fray, depicting the Alps first as a setting for human action and then as a stand-alone feature. The "Miraculous Draught of Fishes," (Konrad Witz, 1444) set on Lake Geneva, became the first landscape painting with a recognizable setting.[60] By the seventeenth and eighteenth centuries, artists routinely used the Alps in their work, relying heavily upon contemporary developments in aesthetics.

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[58] Gavin de Beer, *Speaking of Switzerland* (London: Eyre & Spottiswoode, 1952), 27.
[59] Ibid., 61.
[60] John Wraight, *The Swiss and the British* (Salisbury: M. Russell, 1987), 45.

Tracking artistic and literary progress, if not perhaps even surpassing their interest in the Alps, was early modern science. Spearheading the scientific movement was Leonardo da Vinci, who, although primarily known for his work on anatomy, astronomy and engineering, must be considered a pioneer in the field of physical geography and (what would later become) geology. Fascinated by marine shells contained in the alpine strata, as well the layered strata themselves, Leonardo prepared the first early modern theory of rock formation. Anticipating Saussure's cyanometer by almost three centuries, Leonardo analyzed the relationship between atmospheric thickness and the brightness of the sun. To be sure, Leonardo's notebooks relay a degree of precision observation unsurpassed in its period, but he alone could not transform Europe's alpine mentality. Venturing towards the subjective, however, Leonardo's oeuvre was not without its own anachronistic sublime aesthetics. Asserting that "the heights of mountains are more eternal and more enduring when they are covered with snow during the whole winter,"[61] Leonardo nonetheless failed appreciate the Alps beyond the scientific or practical.

While uncertainty remains regarding the extent of Leonardo's influence on Europe's alpine mentality, a new attitude arose following his death. Challenges to the prevailing paradigm remained the exception, typically motivated by defiance to local myth, however, science and reason increasingly attacked the fallacy of longstanding mythical traditions. The ascent of Lucerne's Mont Pilatus, a peak veiled in superstition, represented a clear manifestation of reason's triumph over alpine mythology. The myth cautioned would-be travelers bent on climbing Mont Pilatus of the damned soul of Pontius Pilate, who raised terrifying storms against those attempting to uncover the

[61] Leonardo da Vinci and Edward McCurdy, *The Notebooks of Leonardo Da Vinci*, 2 vols (London: J. Cape, 1938), 329.

peak's mystery. Indeed so pervasive was the myth that even the council of Lucerne forbid any attempt on the summit, fearing the wrath of Pilate.[62] The first challenge to the peak, undertaken by the Swiss humanist Joachim von Watt, ultimately failed in the face of fear and the mountain's evil spirits. Though unsuccessful, Watt's mentality generated humanist interest in debunking alpine mythology. Declaring that such myths "have no foundation in the laws of nature," Conrad Gessner assumed the reins and ascended Mont Pilatus in 1555, "partly for botanical studies, partly bodily exercise, and for [his] own satisfaction."[63] Soon after, Josias Simler, the author of *De Alpibus commentarius*, continued the newly developed humanist interest in the Alps, describing and classifying the mountains.

Unfortunately, the renaissance of the humanist elite stumbled in the early Enlightenment, as aesthetics emphasized artificial and not natural elements of the landscape, once again reducing alpine interest to its intellectual and functional characteristics; nor did this mentality fully abate through the end of the Enlightenment and Romantic period. Few appeared to advocate such a perspective more than David Hume, who perceived natural beauty only in connection with intellectual progress.[64] By the turn of the nineteenth century, Sir Samuel Egerton Brydges (1762-1837), conveying a typical eighteenth century perspective, could still suppress an intrinsic appreciation of nature:

> The lonely mountains of Savoy, in which Nature revels in all her sublimity, may charm the dreams, and fructify the reason of him who carries thither the treasures of knowledge and thought; but the mountain breezes will blow their freshness, and the smiling valleys will breathe their perfumes in vain

[62] Kirchner, 424.
[63] Ibid., 424-25.
[64] Donald T. Siebert, "Hume as Philosophical Traveler," *Studies in Eighteenth Century Culture* 18 (1988), 191-3.

> for him in whose vacant brain no seeds have been sown. All landscape-painting, all descriptions of natural scenery, unconnected with its operations on the intellectual beings that people it, is of little comparative estimation or use…Magnificent as is the scenery of nature, without the aid of the Mind, it is nothing.[65]

Brydges' perspective was not without precedent or support. Travel accounts through the Alps often highlighted human-derived elements, whether socio-political or modifications of the alpine landscape. All too frequently, travelers deemed rugged nature less enviable than cultivated landscape.

Certainly not mainstream, the humanist mentality began to bear fruit in the seventeenth century as curiosity, health and science gained repute against those who asserted that the Alps possessed little intrinsic value. Since we are here concerned with the rise of alpine science and the mentality of its practitioners, Zurich's Johann Jacob Scheuchzer must be mentioned. The first professional alpine tourist to study the natural history of the Alps, especially botany and mineralogy, Scheuchzer made nine journeys beginning in 1702.[66] Yet Scheuchzer's *Itinera Alpina*, which describes his travels, assumes a rather inconsistent approach. While sections demonstrate his scientific acumen and reasoned methodology, others profess the veracity of dragons in a land "so mountainous and well provided with caves, that it would be odd not to find dragons there."[67] Seeking to prove his dragons were no mere psychosomatic fantasy, Scheuchzer richly illustrated his work with plates emphasizing the comparative anatomy of the creatures.

Taking the reins from their Swiss compatriots in the early to middle decades of the eighteenth century were Albrecht von Haller and Jean-Jacques Rousseau; historical

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[65] Wraight, 24-5.
[66] de Beer, *Early Travelers in the Alps*, 76.
[67] Ibid., 90.

discourse holds these men as fathers of the modern alpine perspective. Haller's poem *Die Alpen (The Alps*, 1729*)*, widely read and translated throughout Europe, and Rousseau's novel *La Nouvelle Héloïse* (1761) depicted the Alps to a European readership finally eager to absorb the natural world.[68] Given the principal argument of this dissertation, that the empirical methodology of de Luc and Saussure catalyzed the shift in alpine mentality, Haller, especially, proves a quintessential figure. *Die Alpen*, in poetic form, elucidated his innovative empirical approach to science. Conducting twenty-five excursions throughout the Alps between 1728 and 1755, his observations offered the reader a degree of accuracy and alertness to minute elements of the natural landscape that would characterize eighteenth century fieldwork and aesthetics.[69] Haller's theoretical tracts emphasize the vigilance of his observations and recognition that fieldwork offered the natural historian a sense of unity and comparison within nature that the cabinet could not instill. Before even Rousseau, Haller exhorted the pure simplicity of alpine life against corrupt urbanism.[70] The influence and support Haller offered de Luc and Saussure suggests that the methodology of his disciples was no mere coincidence. Where Haller and his generation initiated a shift in Europe's cultural and intellectual climate, Haller did not possess the requisite infrastructure, available to the subsequent generation, to effectively or completely overturn the prevailing alpine mentality.

Complementing Haller and Rousseau were a plethora of alpinists, travel accounts and poems professing 'mountain glory'. At last, the language used to describe the Alps shifted from emphasizing the evil and barren to the beautiful and charming. Where the

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[68] Beattie, 121.
[69] Ann Shteir, "Albrecht von Haller's Botany and "Die Alpen,"" *Eighteenth Century Studies* 10, No.2 (1977), 175-77.
[70] Dorothy Roller Wiswall, "A Comparison of Selected Poetic and Scientific Works of Albrecht Von Haller," (Reprint of the author's thesis--University of Michigan 1979), 54; Otto Sonntag, *The Correspondence between Albrecht Von Haller and Horace-Benedict de Saussure* (Bern: Huber, 1990), 27.

‘terrible’ did still exist, it was camouflaged by sublime aesthetics and the intellectual value of experiencing a vast incomprehensible landscape. Like Haller, a number of local and cosmopolitan savants, following the lead of their predecessors in the seventeenth century, pursued their alpine curiosity not through proto-romantic literature, but rather a reasoned scientific approach. Contemplating all facets of natural history and philosophy, savants increasingly ventured into the Alps to observe firsthand the objects of their study. And it is here, intertwined chronologically with Haller and Rousseau in the latter-half of the eighteenth century, that the story of H.B. de Saussure and J.A. de Luc gathers momentum.

~~ Chapter 1 ~~

Crafting Empiricism in a Mechanistic World

Novel in its scope and methodology, Jean-André de Luc's 'Theory of the Earth' was by no means an isolated endeavor.[71] Eighteenth century natural philosophers, like their predecessors, struggled to explain the causal relationships at work in the creation and evolution of the earth's physical structures. Except for his defense of revealed theology, the works of neptunists like Saussure and Werner heavily influenced de Luc, divulging to him an unmistakable synergy between the Noachian deluge and scientific observation.[72] At the heart of this dilemma lay questions surrounding the presence of marine shells in alpine strata, and reduced even further to its most simplest: why did the earth have mountains and what process resulted in their formation?

Geology, though it came into its own in the latter half of the eighteenth century, was still fragmentary in the 1750s.[73] The indoor science of mineralogy precluded large-scale examination of mountains and the un-cohesive observations by philosophers and

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[71] De Luc first began to extensively publish his "Theory of the Earth" and his meteorological tracts in 1772, and continued to supply journal articles and monographs until his death in 1817.

[72] Thomas L Hankins, *Science and the Enlightenment* (Cambridge: Cambridge University Press, 1985), 153; For the larger debate between eighteenth century natural philosophers, see Rhoda Rappaport, "The Earth Sciences," in *The Cambridge History of Science: Volume 4 – Eighteenth Century Science*, ed. Roy Porter (Cambridge: Cambridge University Press, 2003). The debate between neptunism and its counterpart, vulcanism (or plutonism) lay at the heart of eighteenth century physical science. At its most basic, the conflict was between those who believed water to be the catalytic force for continent formation with those who attributed this feat to volcanic action. Neptunism, the older of the two systems – often advocated by physicotheologists, but not exclusively – insisted upon the geological role of water, as the rock strata had their origin in sediments deposited in the oceans; following a series of catastrophic floods, the seas retreated into subterranean caverns. Vulcanism, advocated by the French and geologists such as James Hutton, instead attributed the formation of rock strata to heat; the earth's internal heat warped and dislocated rock strata, which crystallized as it cooled from a molten state.

[73] The term *géologie* was first put to use by de Luc in 1778, but Freshfield asserts it was Saussure who gave the term official currency and prevalence.

miners resulted in the haphazard accumulation of knowledge.[74] Where the 'Systems' of de Luc and Saussure differed from those before them was in their method. Neither accepted the prevailing approach emphasizing limited observation and wild speculation, yet both were indebted to seventeenth and early-eighteenth century theorists. For de Luc, however, the challenge was doubly great. Advocating physicotheology, an approach based on the speculation and piety of the previous century, de Luc faced the additional challenge of legitimizing a conjectural methodology he himself reproached. Earlier theories are too numerous to convey in anything but brutally reductive form, but their most basic judgments are fundamental in approaching de Luc's system.[75] Beginning with Descartes, ambitious savants sought to make their mark by creating a causal system delineating the creation of the terrestrial world. The system required all geological phenomena be factually reduced into a single overarching theory of terrestrial actions, explaining major surface features through observable phenomena and not supernatural causality.[76] Of course, it would take a significant stretch of the imagination to consider this early 'observation' akin to that of the late eighteenth century.

The greatest explanatory leap taken by natural philosophers in the eighteenth century was the explicit acknowledgment that the earth, and its physical attributes and organic bodies, did not conform to Biblical chronology; the earth was a contingent and historical entity, not an immutable phenomenon. For Robert Hooke, despite his persistent adherence to the Scriptures, contingent history presented the sole justifiable causal

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[74] Hans Baumgärtel, "Alexander von Humboldt: Remarks on the Meaning of Hypothesis in his Geological Researches," in *Toward a History of Geology*, ed. Cecil Schneer (Cambridge: MIT Press, 1969), 19.
[75] For an extended analysis of the earth sciences see Paolo Rossi, *The Dark Abyss of Time: The History of the Earth & the History of Nations from Hooke to Vico* (Chicago: University of Chicago Press, 1984).
[76] Rudwick, *Bursting the Limits of Time*, 136.

explanation for fossils.[77] And for de Luc, time functioned as an important gauge of human progress as well as intellectual and moral development. The ability to connect the contingent temporality of human civilization with that of the terrestrial world provided incontrovertible evidence towards a greater understanding of humanity. To understand the history of the mountains was to understand the history of the earth, and to understand the history of the earth was, for de Luc, to understand the history of man. The histories were not only inseparable, but de Luc purported geology to be the only science whose influence surpassed its respective field, offering answers to humanity's most difficult questions:

> Yet if there be a science, in which advances ought to have been made with that scrupulous caution so judiciously recommended by the great master [Bacon] to whom I have just alluded, it is *geology*; - for the history of the earth is inseparably connected with that of man. The other speculative sciences are, for the most part, interesting only to those who cultivate them, and the errors which they may commit are of little consequence to the rest of mankind; but every man is greatly interested in the decision which respect his abode: for if it can once be ascertained to have undergone various revolutions, some of these may have involved the human race, and on them may depend the solution to the question, *What is man?*[78]

This moralizing enterprise of de Luc and Saussure was essential to their valuation of the Alps. Though each stringently separated their scientific observations from the humanistic elements that infused their narratives, their discourse served more than simply late-Enlightenment science. Reminiscent of Rousseau and Haller, their travels functioned as a civilizing enterprise, a moral attempt to disseminate the simplicity and purity of alpine life to cosmopolitan Europe. Moreover, the prize of their ventures was not

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[77] Rossi, 16.
[78] Jean-André de Luc, *An Elementary Treatise on Geology: Determining Fundamental Points in That Science, and Containing an Examination of Some Modern Geological Systems, and Particularly of the Huttonian Theory of the Earth* (London: F.C. and J. Rivington, 1809), 2.

financial or political, like so much science, but epistemological, imbuing Europe with both alpine science *and* morality. If de Luc and Saussure emphasized the role of alpine geology in elucidating the history of humanity, the byproduct of this venture ultimately revealed far more about mankind's present development and morality than of past generations.[79]

For de Luc, the humanistic elements of natural philosophy, or simply 'philosophy' acted, in part, as a set of methodological guidelines for the geologist. The role of the geologist was to give the chaos of geological monuments coherency, and so de Luc likened the natural philosopher's approach to that of the antiquarian:

> Such is the chaos which the geologist is called upon to explain, in the midst of which he must proceed, as the antiquary would among the ruins of Palmyra….The geologist, in like manner, must study the general means employed by nature in her operations, together with the circumstances which have produced changes in them, that he may be enabled to distinguish the causes denoting certain periods, in those monuments of the great succession of natural events which our globe presents to his observation.[80]

The fossils and strata of the geologist, however, were perceived to be more reliable than the monuments of humanity, for as Rudwick insists, nature could hardly be suspected of historical bias or forgery.[81] Yet the standard of seventeenth and early-eighteenth century natural history, curiosity, was insufficient for the de Luc and his colleagues to explain the natural world.[82] Instead, de Luc, much like Saussure, considered an examination of the

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[79] Gillian Beer, "Travelling the Other Way," in *Cultures of Natural History*, eds. Nicholas Jardine, James A. Secord and E.C. Spary (Cambridge: Cambridge University Press, 1996), 323.
[80] Jean-André de Luc, *Letters on the Physical History of the Earth: Addressed to Professor Blumenbach Containing Geological and Historical Proofs of the Divine Mission of Moses. To Which Are Prefixed Introductory Remarks and Illus. Together with a Vindication of the Author's Claims to Original Views Respecting Fundamental Points in Geology* (London: F. C. and J. Rivington, 1831), § 12-13.
[81] Martin Rudwick, "The Shape and Meaning of Earth History," in *The New Science of Geology: Studies in the Earth Sciences in the Age of Revolution* (Aldershot: Ashgate, 2004), 308.
[82] Katie Whitaker, "The Culture of Curiosity," in *Cultures of Natural History*, eds. Nicholas Jardine, James A. Secord and E.C. Spary (Cambridge: Cambridge University Press, 1996), 76.

most common phenomena the task of the natural philosopher. The anomalous, so long the foundation of armchair science and cabinet specimens, was not relegated to extinction but remained an integral aspect of a paradoxically dualistic science based upon globally connected phenomena and regional contingency.

Expressing the co-dependence of geology on general and immutable natural laws as well as historical contingency, de Luc emphasized the need to establish causal relationships that led to geological periodization. Geographical circumstance likewise functioned symbiotically with temporal phenomena to construct a terrestrial environment local in nature. Clearly a subtle appreciation of time and local variation was required to construct a system of the earth able to establish the order of the earth's formation and periodize terrestrial events into sequential epochs. Taking his analysis of temporal phenomena a step further, de Luc realized that the geologist, in assessing causal relationships, needed to realize the dichotomy between phenomena that had ceased to act, and those which still occurred:

> We saw that an essential distinction was to be made among the various phenomena which the surface of the earth exhibits with respect to their causes, determining of each of them whether the causes which have produced it are *still in action*, or have, at some epoch, *ceased to act*. If this distinction be possible, it evidently becomes a first guide in the research of causes, which will prevent many errors.[83]

The geologist therefore struggled to uncover the state and cause of continent formation at their inception, attempting instead to pinpoint a rough estimate of the elapsed time. Science has since proven de Luc's dichotomy incorrect, but there is little doubt this temporal distinction proved an integral presupposition to his physicotheology.

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[83] De Luc, *An Elementary Treatise on Geology*, 36.

Where de Luc again differed from the majority of his contemporaries, although less so from his seventeenth century predecessors, was his invocation of scriptural chronology. Passionately arguing the veracity of Noachian history and the significance of the Deluge, de Luc emphasized the continents' ephemeral existence. Accepting Genesis' chronological succession, revealed theologists in no way held the six days in a literal sense as a period of twenty-four hours. Instead, they considered each day as merely a consecutive epoch or period delineated by an indeterminate amount of time. Nonetheless, despite time's 'agency', no single determinate causal relationship could be attributed to any specific space of time, forcing de Luc to reduce phenomena to vague periods or epochs.[84] He eventually revised his theory upon contemplating new observations and the insight of his colleagues, but he initially maintained a binary history of the continents in which a 'great revolution' - the Noachian deluge - separated the two major periods of continent formation. Following the slow subsidence of the seas - which he considered to be of greater importance than the existence of alpine fossils - the continents 'arose' to assume their present location.[85] Here, the mountains starred front and center as an island repository (or Noah's ark) for the earth's flora and fauna. Not unlike their very real function for the Swiss, the mountain peaks protected organic life, offering a temperate sanctuary to weather the flood and an environment radically different from that of the modern Alps.

Advocating revealed theology, de Luc ardently sought out natural chronometers to verify his invocation of Mosaic history. Defying the geological trend that recognized the extensive antiquity of the earth, de Luc's detailed observations reinforced his conviction

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[84] De Luc, *Letters on the Physical History of the Earth*, 9.
[85] Ibid., 12.

that the Noachian deluge occurred within the recent past; the continents were ultimately of little antiquity, and chronologically preceded the earliest human monuments by little time. To prove his allegation that the formation of the earth was a recent event, he argued, much like James Ussher over a century earlier, that the earth was approximately four thousand years old;[86] Ussher approximated the date to be 4004 B.C. Historians of science have lambasted his endeavor to substantiate this thesis, yet his efforts were truly innovative. These natural chronometers ranged from an assessment of the thickness of glacial ice, the degree of preservation of alpine fossils, and most impressively, an examination of equatorial coral growth. Making the (ostensible) assumption that coral grew rapidly, de Luc insisted that the actual age of the earth could not be more than a few millennia since the process of coral growth would have prevented passage though the Red Sea, which had obviously not occurred.[87] By the same token, his criticism of vulcanism appears inspired by a similar devotion to terrestrial observation, and so de Luc acknowledged its erroneous basis since there was no account of it in Scriptural history or the natural world.[88]

Moreover, the ramifications of de Luc's verification of Mosaic history must be emphasized. Not only did decisive and observable phenomena substantiate Mosaic chronology, but de Luc considered all other theories of the earth invalidated by the veracity of his evidence.[89] He criticized his colleagues for failing to consult the physical world with the same tenacity he himself employed, and for basing systems upon hypothesis rather than observable phenomena. Since revealed theology was just that,

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[86] De Luc, *An Elementary Treatise on Geology*, 348.
[87] Jean-André de Luc, ''Reflections on the Zodiacs Found by the French in Upper Egypt,'' *Philosophical Magazine* 13 (1804), 374.
[88] De Luc, *Letters on the Physical History of the Earth*, 139.
[89] Ibid., 49.

revealed, de Luc argued that Mosaic history could not be fictitious for the story could not otherwise be explained empirically; had Moses been ignorant of geology and physics, the Scriptures could not have described recognizable geological phenomena.[90] Above all, de Luc sought to demonstrate that the earth and the history of its myriad phenomena authenticated Genesis; the raw observable 'facts' substantiated the 'stories' provided by the Scriptures. Purportedly never faltering in his devotion to the truth, it is clear de Luc naively considered himself the sole messenger of accurate science.

With geological fact and deduction ostensibly authenticating Mosaic history, the moral implications for humanity were undeniable as proponents faithfully maintained Genesis to be the true path of terrestrial and therefore human development. Despite de Luc's insistence that he considered geological phenomena more basic and significant than the Scriptures, he feared human history would be vague and uncertain if geology proved Genesis fictional.[91] Of course, de Luc's implicit assumption that humanity required geology to validate Genesis appears nothing more than a zero-sum game. In hindsight, the inherent contradiction lies within the fact that de Luc clearly believed mankind possessed an intrinsic teleology, and if geology proved Genesis incorrect and human history and morality appeared uncertain, science would compromise humanity. At the same time, de Luc recognized a natural telos, and he, like the Calvinist church, accepted contingency within the physical world.[92] Ironically, not only was geology used to verify Mosaic history, but it was likewise used to undermine physicotheology. De Luc, at the heart of the dispute, understood better than any other that the scientific climate of Europe no

[90] Gillispie, 61.
[91] De Luc, *An Elementary Treatise on Geology*, 4.
[92] Rudwick, *Bursting the Limits of Time*, 234.

longer approved of revealed theology, labeling its practitioners ignorant outcasts.[93] Where others perceived the ignorance of revealed theology, de Luc believed himself inwardly rewarded for his scientific forays. Thus, he made no attempt to conceal his underlying religious motives, choosing to advocate religion in an irreligious age. Guided not by resolute faith in the supernatural but reason and factual deduction, it would be a mistake to consider de Luc either a fundamentalist or biblical literalist.[94] De Luc adamantly contended that he approached geological fact as a fundamental truth more basic and important than the defense of Mosaic history:

> I have explained it, for the purpose of fixing more strongly the attention of my readers; but I have never recurred to it for the support either of the facts which I have brought forward, or for the conclusions which I have deduced from these facts; for this would have been a *petitio principii*. On this great point, truth has been my leading object.[95]

The ensuing result was a geological system that shirked determinism despite conforming to Mosaic history, creating a tense relationship between human history and the terrestrial environment.

Factual Observation and the Suppression of Unfounded Speculation

Critical of Newtonian science, eighteenth century natural philosophy languished in what de Luc considered a self-perpetuating pit of speculative and reductive mechanical philosophy. "It is an assertion we very frequently hear made," de Luc insisted, "that human nature is becoming daily more enlightened. And, it may seem to be an assertion too true to leave room for any doubts: it is, however, equivocal, and to admit it without

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[93] De Luc, *Letters on the Physical History of the Earth*, 47. De Luc criticized his colleagues for cowering in the face of this attack and reproached the sectarian division of natural philosophy. This division, he believed, rested upon hypothesis or fallacious evidence in an attempt to undermine Mosaic history.
[94] Rudwick, *Bursting the Limits of Time*, 153.
[95] Jean-André de Luc, *Geological Travels*, 3 Vols. (London: F.C. and J. Rivington, 1810), 5.

proper examination, would lead to the most mischievous consequences."[96] Continuing, he argued that "it is plain, then, that we should judge hastily to pronounce an age enlightened, merely because we hear much talk of knowledge in it; it is necessary first to ascertain in what this knowledge consists."[97] Like de Luc's scathing assessment of Enlightenment knowledge and progress, late-century philosophers challenged this dominant paradigm for its perceived support of political absolutism, the status quo and meta-systems.[98] Conversely, de Luc attacked Enlightenment science not for its socio-political ideology or reductive method, but rather its specific epistemological approach: speculative deduction that encouraged 'armchair' science. Study inside the museum or cabinet was regarded as the pinnacle of science and its practitioners attained the greatest prestige, in turn relegating fieldwork to a secondary occupation fulfilling a means to an end.[99] For de Luc, only precision observation directly from the field could enable a geologist to accurately advance a theory of the earth.

Assessing late-Enlightenment vitalism, Peter Hans Reill has noted that anti-mechanists have been typically labeled as old-fashioned religious conservatives, religious enthusiasts or young proto-romantics; all outsiders that attacked the Enlightenment project. It would be a mistake, however, to label de Luc a radically anti-Enlightenment savant, for his geological discourse offers little to substantiate a vitalist or proto-romantic mentality. These latter designations emphasize a subjective interaction between the scientific observer and the terrestrial world.[100] Instead, de Luc recognized this interaction

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[96] De Luc, *Letters on the Physical History of the Earth*, 41.
[97] Ibid., 43.
[98] Peter Hans Reill, *Vitalizing Nature in the Enlightenment* (Berkeley: University of California Press, 2005), 5.
[99] Rudwick, *Bursting the Limits of Time*, 42.
[100] Reill, *Vitalizing Nature in the Enlightenment*, 23.

but largely suppressed it. For de Luc, the observer performed a disinterested and quantitative role uncovering geological phenomena:

> And first, it is essential to remark, that knowledge, considered as the result of the observations and enquiries of man, divides itself into two branches, different in their nature, and which do not always keep pace with each other: the one is, the collection of axioms and facts, which are in themselves independent of man, and are supplied by objects without us; the other is, the collection of theories or systems deduced from these data.[101]

De Luc's epistemological dichotomy featured predominantly in his criticism of early-Enlightenment mechanism; and knowledge based upon speculative science certainly outpaced factual collection. Of course, the human element implicit in deductive reasoning must itself be qualified within de Luc's assessment, for though he intimated an epistemological hierarchy, his own deductive logic in no way implied a subjective element.

Where the paths of man and nature intersected, namely establishing man's place in the natural world and an understanding of his terrestrial past, the explanatory link occurred *ex post facto*; even systems of the earth required the primacy of fact over hypothesis. Among his colleagues, however, de Luc perceived significant methodological error. Science was the province of a select group of men able to devote themselves to its advancement, yet paradoxically, it was the minds of these men that presented a liability to the empirical construction of knowledge:

> If their instructions were limited to facts, without the addition of commentaries, science thus disseminated among mankind, would, while it augments, always continue real; but the human mind is prone to generalize…and thus it frequently happens that when new discoveries are made, facts are so blended with hypotheses, that at first they are confounded together: so that they who cannot or will not receive any

[101] De Luc, *Letters on the Physical History of the Earth*, 41-2.

> instruction but such as is easy, and requires little attention and reflection, can hardly fail to fall into error.[102]

While generalization offered immediate results, de Luc argued, complex phenomena required simplification, not generalization. Much of his meteorological work was concerned with what he called the "co-effects" of phenomena, namely their interconnection, although de Luc nonetheless cautioned against over-complication. Combined with the mind's eagerness to draw inferences without the requisite data, de Luc firmly believed that early Enlightenment philosophy inhibited epistemological progression:

> The immortal Bacon repeatedly cautioned those who devoted themselves to the study of nature. The mind is at times so eager to draw inferences, that it will not stop to collect all the data necessary for deducing legitimate conclusions…Hence arises a considerable obstruction to the real advancement of science, the progress of which is much less retarded by ignorance than by error.[103]

Offering a précis of de Luc's methodological criticism, it is clear he elevated fact above that of his predecessors, rejecting both subjective analysis and unfounded hypothesis. De Luc's distinction between fact and purportedly objective commentary further dichotomized his epistemological hierarchy, establishing a rift between the general and the specific. Notwithstanding the proposed unity of global phenomena, regional contingency existed, forcing the natural philosopher to acknowledge and account for specific facts. In many respects, de Luc's criticism of knowledge foreshadowed the professionalization of science, as natural philosophers increasingly recognized that the obligations of the serious scientist precluded the determined, but ultimately amateur, savant. With hordes of late-Enlightenment natural philosophers seeking out precise

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[102] Ibid., 43.
[103] De Luc, *An Elementary Treatise on Geology*, 1.

observation and fact, an unmistakable element of empirical science, de Luc and his colleagues took to the earth. For the Alps, this epistemological approach meant its uppermost regions, which functioned as a natural repository, became recognized as a veritable geological treasure trove; and for science, de Luc's hierarchy of knowledge anticipated the separation of individual disciplines, signaling the end of the comprehensive natural philosopher. Upholding traditional natural philosophy where necessary, but adding to it where required, de Luc certainly represented a new breed of philosophy.

Alerting his colleagues to the flaws of over-generalization, de Luc similarly cautioned against absolute knowledge. Guided by Baconian method, and his conviction in the resilience of Newtonian science (where Aristotelian and Cartesian had instead failed), de Luc admired Bacon as the father of causal investigation. Concurring with Bacon's assessment of incontrovertible knowledge, de Luc cautioned his peers against attributing final causes to terrestrial phenomena until natural philosophy possessed sufficient data to ensure future contradictions did not arise:

> In thus assigning a *final cause* to these pretended effects, Mr. Playfair has forgotten the precepts of Bacon, notwithstanding the high estimation in which he professes to hold them. That true philosopher strongly recommended to naturalists not to recur to final causes till natural history and natural philosophy should be sufficiently advanced, to afford a well-grounded hope that the effects, now ascribed to certain causes, might not hereafter be shown to have to connection with them.[104]

Contradiction in science, de Luc believed, would only result in increased skepticism. Shirking hypothesis, he himself walked a fine line with regard to final causation. His

[104] Ibid., 106.

discourse abounds with a tacit - and at times explicit - arrogance of a natural philosopher certain he holds the one true system of the earth.

Putting the sum of de Luc's methodological critique together, his criticism of the Scottish geologist James Hutton's theory of the earth offers a useful case study to examine de Luc's method and criticism of traditional Enlightenment geology. Hutton's *Theory of the Earth* (1795), unlike de Luc, gained prominence following his death. Little known on the continent, John Playfair's more elegant re-phrasal of Hutton's obscure prose cast it into the spotlight. With de Luc attempting to bring science to the people as well as the erroneous nature of Hutton's theories to light, he published a series of condemnatory letters in several periodicals, among them the *Monthly Review* and the *British Critic*. In his *Elementary Treatise on Geology*, de Luc expressed his principal criticism: that Playfair's idolization of Hutton led him to falsely believe that the Huttonian system was founded upon direct proof and rigid demonstration.[105] Playfair, however, neglected to document de Luc's objections, contending the latter's analysis must surely be frivolous in light of Hutton's unquestionable accuracy. Though continent formation was at the centre of their debate, Hutton rebuked de Luc for his physicotheology, suggesting that the use of science to affirm theology was excessively distasteful.[106]

The image historians of science have depicted of Hutton is largely favourable, but recent commentaries do espouse a mentality not unlike de Luc's. Calling attention to Hutton's "far-reaching suppositions" gleaned from geographically limited fieldwork, it is

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[105] Ibid., 199.
[106] Hankins, 155. Separating science and religion, Hutton was still profoundly religious, forcing Playfair to remove supernatural references.

apparent that Hutton slighted empirical evidence in favour of hypothesis.[107] The vituperative nature of the de Luc-Hutton dispute has undoubtedly led historians, sectarian in their distaste for the fusion of religion and science, to favour Hutton. With this in mind, Roy Porter has labeled de Luc's *Elementary Treatise on Geology* merely a dogmatic dissertation intended to settle "old scores against rival systems."[108] Furthermore, Noah Heringman has suggested that de Luc's criticism of Hutton inspired a secularist backlash against physicotheology, instigated by Erasmus Darwin and Percy Shelley.[109] It has even been remarked that de Luc requires notice only for his extensive criticism of Hutton![110]

De Luc's most scathing criticism of Hutton was his attack upon the limited geographical scale of his evidence. With Saussure's *Voyages dans les Alpes* as corroborative evidence, Hutton believed his forays into the Scottish Highlands sufficient to propose a universal theory of mountains.[111] Where Playfair considered Hutton's propositions adequately demonstrated, de Luc claimed the exclusion of further relevant phenomena, notably those beyond the reaches of Hutton's travels:

> It was only in Scotland that Dr. Hutton and Mr. Playfair had observed any examples of the phenomena of which I am now speaking: of those on the continent they knew nothing but by the accounts of others…but in this instance, as well as in many others pointed out in my Elementary Treatise, these gentlemen have selected the particular facts which have appeared to them to agree with their own hypotheses.[112]

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[107] Dean, 6.
[108] Porter, *The Making of Geology*, 211.
[109] Heringman, *Romantic Rocks*, 18.
[110] Joan Eyles, "William Smith: Some Aspects of his Life and Work," in *Toward a History of Geology*, ed. Cecil Schneer (Cambridge: MIT Press, 1969), 166.
[111] John Playfair, *Illustrations of the Huttonian Theory of the Earth* (Urbana: University of Illinois Press, 1956), 402.
[112] De Luc, *Geological Travels*, Vol. 2, 434.

At the same time, de Luc's self-aggrandizing criticism emphasized his own extensive travels.[113] Where geologists like Hutton, bereft of far-reaching fieldwork disagreed with de Luc, he insisted that colleagues with a similar breadth of travel corroborated his work. Moreover, Hutton, de Luc presumed, testified that he had adhered to scientific method, where in fact he had not, neglecting to minutely survey terrestrial phenomena:

> It is this method, to which, no doubt, he [Hutton] conceived himself to have scrupulously adhered, which persuaded him, and may persuade, many of his readers, that, without the necessity of minutely surveying all the objects presented by the earth's surface, or even going out of his own cabinet, a "*table of Sicilian marble*," or "*jasper*," and some other specimens forward from his collection of minerals, might lead to the formation of a *Theory of the Earth*.[114]

De Luc believed that Hutton had prepared a theory informed only by his limited investigation of Scottish topography; geological phenomena ostensibly confirmed preconceived ideas. Moreover, not only does Hutton make frequent reference to final causes, but these are inferred through phenomena that bear little relation to the facts and system at hand.[115] Bereft of plausible familiarity with the Alps, Playfair attempts to explain their formation and erosion, hazarding what de Luc labels fictional conjectures. The tacit assumption made here is that a familiarity with terrestrial phenomena can only be acquired through personal observation.

Ultimately, de Luc's critical analysis of the Huttonian system offers the opportunity to succinctly formalize his methodology. "It is by adding observation to observation, and keeping to their immediate consequences, not by raising one hypothesis upon another in endless succession," de Luc insisted, "that men acquire knowledge."[116]

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[113] De Luc, *An Elementary Treatise on Geology*, 38.
[114] Ibid., 227.
[115] Ibid., 202.
[116] De Luc, *Letters on the Physical History of the Earth*, 15.

The failure to distinguish hypothesis from fact hindered the advancement of knowledge and concealed the true path of geology. Or, more succinctly stated, "to defend without deep facts is to injure."[117] Second, spatially limited observation could not provide geology with sufficient evidence to form systems. Only when the geologist had consulted all particular phenomena over a wide geographical range could generalization be permitted.[118] Combined, the need for extensive fieldwork, which itself required a dedication to precision, contributed to a unique methodology that would forever change the natural philosopher's approach to his craft.

Unity in Diversity: An Agenda to Study Nature's Relations

To study the terrestrial world and its complex phenomena, both de Luc and Saussure insisted that the natural philosopher comprehend nature's unity, a task that required a certain degree of simplification and preparatory work. Historians of science have largely attributed the idea of nature as a global entity to Humboldtian science, and it is unquestionably one of Humboldt's greatest legacies, but he was certainly not the first to perceive this flaw in the mechanist paradigm.[119] Where Newton's disciples reduced nature to the quantification of anomalous or curious phenomena - believing aberration exposed natural operations to a greater extent than the ordinary - de Luc and Saussure emphasized the role of common phenomena and their interconnection.[120] "The end, indeed, of the geological observer, is," Saussure suggested, "not to form a cabinet of

[117] De Luc, *An Elementary Treatise on Geology*, 6.
[118] Ibid., 385.
[119] Noah Heringman, "The Rock Record and Romantic Narratives of the Earth," in *Romantic Science: The Literary Forms of Natural History*, ed. Noah Heringman (Albany: State University of New York Press, 2003), 63.
[120] Simon Schaffer, "Natural Philosophy," in *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*, eds. G. S Rousseau and Roy Porter (Cambridge: Cambridge University Press, 1980), 84.

curiosities, but he must carry away fragments of things apparently the most common, when an exact determination of their nature may be interesting to theory."[121] Second, Saussure suggested that generalization required the natural philosopher to demonstrate an awareness of the whole: "It is in vain, however, that mountains offer opportunities for such observations if the student does not know how to look on these great objects as a whole and in their more general relations."[122] For de Luc, an investigation of common phenomena included the study of their interconnection, in turn leading to an appreciation of the physical world as a synchronized entity. With this in mind, de Luc's epistemological approach rested upon the connection of effects rather than the creation of absolute but incomparable knowledge. Moreover, given the complexity of associated phenomena, de Luc stressed that nature's most general or common operations offered a more simplistic approach to uncover its relations.[123] An appreciation of nature's unity connected the dots of physical science, providing a path for the natural philosopher to follow. Ironically, de Luc appeared so focused on the similarity of natural phenomena across Europe that his *Geological Travels* (1810) often obscured the precise location of his observations. An anonymous reviewer of this tract remarked that many of de Luc's observations could equally reflect the regions around Paris, the Netherlands or England: "I confess, however, sir, that I was somewhat disappointed in finding no attempt in all

[121] Horace-Benedict de Saussure, "Agenda, or a Collection of Observations and Researches the Results of which may Serve as the Foundation for a Theory of the Earth," *Philosophical Magazine* 5 (1799), 140.
[122] Horace-Benedict de Saussure, "*Discourse Préliminaire*,'' in *Voyages dans les Alpes, Précédés d'un Essai sur l'Histoire Naturelle des Environs de Genève* (Neuchâtel: Samuel Fauche, 1779).
[123] De Luc, *Letters on the Physical History of the Earth*, 8.

these details, at pointing out the exact place…whence these…[phenomena] took place, according to the theory of M. DeLuc [sic]."[124]

The question of natural unity is often at the heart of romantic science, epitomized by the conflict between mechanism and organicism, yet neither de Luc nor Saussure emphasized the purposeful development and ordered patterns of nature to the same degree as romantic science.[125] Rather, each pushed the limits of mechanism without wholly annihilating its general precepts. The ensuing methodology explored nature's reciprocal interactions, but to an extent that subordinated the qualitative to the quantitative. Challenging early-mechanist thought, however, an unavoidable paradox arose as natural philosophers emphasized the "whole" only to increase the precision of their measurements. In reality, this dilemma was of little concern since the quantifying spirit of the late-Enlightenment demanded a shift towards greater accuracy, but de Luc, Saussure and later Humboldt insisted that natural philosophers balance their research between minute measurement and an awareness of the whole.[126] Yet the value of this shift towards the study of immovable objects cannot be overstated. With cabinet specimens insufficient for the new empiricism, natural philosophers increasingly ascended the mountains for firsthand experience.

Meaningful fieldwork required a degree of planning largely foreign to the early stages of scientific travel, however. Especially in remote regions, fieldwork entailed extensive preparations to arrange itinerary, accommodation and instrumentation. Planning

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[124] "A Review of the First Volume of M.J.A. de Luc's *Geological Travels* in the North of Europe: With Remarks on Some of the Geological Points Which are Therein Discussed," *Philosophical Magazine* 36 (1810), 5.

[125] Robert J. Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002), 10-12. Given that romantic scientists, notably Goethe, distinguished rocks from organic forms due to a lack of dominion over their parts, it is unlikely geology could ever be perceived as an organic and romantic science.

[126] Geikie, 184.

likewise served the natural philosopher by maintaining the focus and productivity of his study. Saussure feared that the sheer wealth of objects of interest in the Alps might discourage systematic observation if the unprepared scientist haphazardly engaged the natural world.[127] So strongly did Saussure feel about purposeful fieldwork that he compiled a protracted "Agenda" delineating the proper method and planning required for scientific travel:

> When about to contemplate objects so complex as those that must be studied to found on observation the basis of a theory of the earth, it is indispensably necessary that we should previously form a regular plan; prescribe for ourselves a certain order; and minute down, if I may use the expression, the questions which we wish to propose to nature. As the geologist commonly studies and observes while traveling, the least distraction may deprive him, perhaps for ever, of an interesting object.[128]

The *Agenda* provided a list of 327 questions or observations that the traveler should be on guard for, covering astronomy, chemistry, physics, historical monuments, and phenomena concerning the seas, coasts, rivers and plains; within the alpine world, this list extended to questions about general mountain phenomena (the presence of mineral veins, snow lines, glacier movements), strata, valleys, volcanoes, mines and the three types of mountains, primitive, secondary and tertiary. Originally published as an addendum to Saussure's *Voyages dans les Alpes*, the *Agenda* was subsequently published in the *Philosophical Magazine*, giving it greater exposure; to delineate the geology of the British Isles, the Geological Society of London even adopted the "path-breaking, factual, scrupulous inquiry" the *Agenda* recommended.[129]

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[127] Saussure, "Agenda," *Philosophical Magazine* 3 (1799), 34.
[128] Ibid., 33. Saussure was not alone in providing instruction manuals delineating the proper approach to fieldwork, for by the mid-eighteenth century, a demand arose for such manuals that explained the equipment and means to collect specimens.
[129] Porter, *The Making of Geology*, 181.

Whether implemented by informed philosophers or amateur travelers, Saussure clearly hoped that his suggestions be used to further the bounds of science.[130] Included in his recommendations were a list of errors to avoid while making observations. The most insidious source of error, Saussure believed, was the observer's memory, which led him to advocate meticulous note-taking. Travelers were instructed to briefly record complex observations on the spot, and then compile the sum of their notes within the following twenty-four hours.[131] To avoid erroneous recollection, Saussure suggested the traveler collect specimens. Here again, Saussure prepared his readers, providing a list of instruments invaluable to the geological traveler. Some were optional, yet the list included two sizes of miner's hammer (a ten ounce and a forty ounce), two stone cutter's chisels, steel (to test fossil hardness), an artificial magnet, a magnifying glass, telescope, compass, barometer, thermometer, sextant, map, paper for wrapping specimens and a blow-pipe; ever wary of the alpine environment, he even instructed his readers to bring a solid walking pole, iron cramps for the ice, and good clothes for protection from the elements.[132] Whether for the natural philosopher or a European readership, Saussure clearly hoped that his *Voyages* and *Agenda* might motivate his fellow citizens: "If my descriptions give my readers some part of the pleasure I have had myself in my travels – above all, if they serve to incite in some of them a desire to study and to advance a science in the progress of which I take an eager interest, I shall be well pleased and well rewarded for my exertions."[133]

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[130] Saussure, "*Discourse Préliminaire.*"
[131] Saussure, "Agenda," *Philosophical Magazine* 5 (1799), 139.
[132] Ibid., 217.
[133] Saussure, "*Discourse Préliminaire.*"

With a practical method of engaging nature combined with the sum of de Luc and Saussure's innovative approaches to geology and meteorology, the epistemic stage was finally set for the penetration and comprehension of the high Alps. Drawing on this foundation, fieldwork, precision instrumentation and sublime aesthetics ultimately transformed Europe's alpine mentality. In recognizing the debt to de Luc and Saussure for specific elements of alpine science, each must not go unnoticed for their role in establishing the precepts of this science.

~~ Chapter 2 ~~

Engineering Alpine Science: Fieldwork, Precision Instruments and the Decontextualization of Knowledge

Where Haller, and subsequently de Luc and Saussure advocated firsthand observation, early to mid-eighteenth century natural philosophers characterized fieldwork as merely a means to an end, a crude element of science to be carried out by students or subordinates. Eighteenth century Europeans possessed an incessant curiosity for the natural world, and among the Swiss in Geneva, most wealthy citizens possessed a cabinet adorned with natural specimens.[134] Yet such specimens symbolized the height of cosmopolitan fashion, a luxuriant amusement or hobby. Faced with this dilemma, de Luc and Saussure challenged both themselves and colleagues to empirically approach the natural world; only with empiricism firmly established could the shift towards precision instrumentation and fieldwork occur.

Sure enough, the perception of remote areas as uncivilized did much to hinder most cosmopolitan savants from leaving the safety of their cabinets to venture into raw nature. Unfortunately for alpine science, the Alps appeared doubly damned. As scientific travel accounts began to appeal to European curiosity, exotic or colonial travels attained the greatest interest. Europeans craved distractions from their own mundane existence:

> In the Old World, nations and the distinctions of their civilization form the principal points in the picture; in the New World, man and his productions almost disappear amidst the stupendous display of wild and gigantic nature….The savages of America, who have been the objects of so many systematic reveries, and on whom M. Volney has lately published some accurate and intelligent observations, inspire less interest since celebrated

[134] Jean-Marie-Jerome Fleuriot de Langle, *A Picturesque Description of Switzerland by the Marquis De Langle. Translated from the French* (London: J. Connor, 1791), 130.

> navigators have made known to us the inhabitants of the South Sea islands, in whose character we find a striking mixture of perversity and meekness.[135]

The plethora of contemporary travel accounts corroborate Humboldt as travelers, failing to venture off the beaten path, focused almost exclusively on socio-political elements of Switzerland. Even as early as 1685, Gilbert Burnet could remark that Geneva, so well known, required little elaboration in his travel narrative.[136] The poor roads, eternal snow and sheer height of the Alps offered even the bravest explorer little reason to venture into the unknown. Reinforcing the status-quo, guide books, like Abraham Ruchat's *Délices de la Suisse* (1714), provided a network to make travel physically and culturally convenient.[137] Their location suggested otherwise, but the high Alps remained as remote as the far reaches of the world.

Instead, whether propelled by an exotic or erotic desire for the sexuality of Pacific natives, or an attempt to escape mundane urban and industrial conditions, Europeans took less pleasure from continental science than the curiosity surrounding newly discovered 'others'. The journeys of de Luc and Saussure, despite opening of the Alps to science, could not, and did not, rival the exotic expeditions to the forests and mountains of South America, or the maritime voyages to the South Pacific. History has reinforced this distinction, elevating Alexander von Humboldt to mythical status, belittling Saussure, and relegating de Luc to an acerbic footnote. Indeed, Humboldt's veneration of Pacific travel

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[135] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. I, xxi.
[136] Gilbert Burnet, *Burnet's Travels – Or, a Collection of Letters to the Hon. Robert Boyle, Esq; Containing an Account of what Seem'd most Remarkable in Travelling thro' Switzerland, Italy, some Parts of Germany, &c in the Years 1685, and 1686* (London: Ward and Chandler, 1737), 5.
[137] Leslie Stephen, *The Playground of Europe*, 2; Melissa Calaresu, "Looking for Virgil's Tomb: The End of the Grand Tour and the Cosmopolitan Ideal in Europe," in *Voyages and Visions: Towards a Cultural History of Travel*, eds. Jaś Elsner and Joan-Pau Rubiés (London: Reaktion Books, 1999), 141.

was typical of his day, stemming from his reading of Georg Forster's *Delineations of the South Seas Islands* (1777); Saussure instead idolized the publications of Colonel William Windham and Richard Pococke, who ventured to the glaciers of Chamonix in 1741.[138] Europe largely concurred with Humboldt, with the high Alps in effect remaining an acknowledged but insipid element of continental Europe, exciting little interest among the general population and scarcely more among theorists publishing systems of the earth.

Where scientific expeditions did garner public attention, both in the Alps and elsewhere, natural philosophers feared that readers' interests lay in the drama of toilsome mountain ascents, not the science that guided exploration.[139] To enthrall the public, publishers shaped narratives to the eyes of the reader, while concurrently avoiding any alienation of the scientific community.[140] This thought in mind, Saussure sought to provide the reader with greater narrative variety, recording the socio-cultural character of alpine peoples and the sublime sensations that the mountains elicited. In his *Geological Travels*, however, de Luc directly refutes any intention to falsely engage the reader, suggesting instead that his wholly functional narrative was restricted to the tedium of the subject.[141] Given such ostensible monotony, it seems surprising that de Luc, who sought to raise the general curiosity of the public, attempted to deconstruct the emerging professional practice of writing solely for colleagues.[142] Innovation was the responsibility of professionals, and both de Luc and Saussure believed that even the observations of the

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[138] Alexander von Humboldt, *Cosmos: A Sketch of a Physical Description of the Universe,* Vol. 2 (London: H.G. Bohn, 1849), 371; Freshfield, 1.
[139] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America*, Vol. 1, xx.
[140] Tim Fulford, Debbie Lee, and Peter J. Kitson, *Literature, Science and Exploration in the Romantic Era: Bodies of Knowledge* (Cambridge: Cambridge University Press, 2004), 93.
[141] De Luc, *Geological Travels*, Vol. 1, 117.
[142] Samuel Horsley, "M. de Luc's Rules, for the Measurement of Heights by Barometer, Compared with Theory, and Reduced to English Measures of Length, and Adapted to Fahrenheit's Scale of the Thermometer: With Tables and Precepts, for Expediting the Practical Application of Them," *Philosophical Transactions* 64 (1774), 218; De Luc, *Geological Travels*, Vol. 1, 111.

common traveler could be of cumulative value to science. To turn the pleasure traveler into a scientific instrument required scientific narratives to be educational yet engaging. For the pioneers of scientific fieldwork, however, factual observation clearly subordinated narrative, which served only to coherently link successive observations.[143]

In Praise of Fieldwork

Regardless of the public's desire for the dramatic or exotic, fieldwork in the mid-eighteenth century was still in its infancy; even more so with regard to the Alps. The socio-political life of the Swiss was well documented in travel narratives; others still called attention to the landscape, emphasizing the sublimity of the Alps. The question then, is: if neither alpine travel nor sublime aesthetics were unfamiliar, why did scientific fieldwork in the high Alps require additional legitimization? Parts of an answer have been alluded to thus far: the primacy of the cabinet, the fear of perilous travel in a region beset by a hostile mythico-historical past, and the failure of early-Enlightenment mechanism to encourage factual observation in place of unfounded speculation. Overturning the status-quo required a two-pronged approach: the first called for the deconstruction of long-standing prejudices, and the second required the institutionalization of the 'other'. The high Alps, in this instance, represented the 'other' - the fieldwork of de Luc and Saussure functioning not only as a scientific encounter, but a concurrent cultural encounter. In effect, travel narratives mediated this encounter with the unknown, structuring it for the masses, and in turn, domesticating the mountains by bringing them under the "yoke of humanity."[144]

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[143] Alexander von Humboldt, *Cosmos*, Vol. 2, 435.
[144] Peter France, *Politeness and its Discontents: Problems in French Classical Culture* (Cambridge:

For de Luc and Saussure, mountains, and the Alps in particular, offered a plenitude of evidence to substantiate their theories of the earth. Few geographical regions, Saussure insisted, could provide the geologist so great a value:

> These great chains, the tops of which pierce into the upper regions of the atmosphere, seem to be the workshop of nature and the reservoirs whence she draws the benefits and the disasters she spreads over our earth, the streams which water it, the torrents which ravage it, the rains which fertilize it, and the storms which spread desolation.[145]

Moreover,

> It is the study of mountains which above all else can quicken the progress of the theory of the earth or geology. The plains are uniform, and allow the rocks to be seen only where these have been excavated by running water or by man. The high mountains, on the other hand, infinitely varied in their composition as in their forms, present gigantic natural section…[that] can be seen with the greatest clearness and at one view.[146]

Projecting the aesthetics so in vogue in the early nineteenth century, Alexander von Humboldt expanded on Saussure's raw empiricism, claiming that the mountains furnished "a richer and more beautiful variety of individual forms."[147] An apposite analogy of alpine strata might be to that of the 'cradle of civilization'; the mountains presented the geologist with ample, and often easily observable evidence to construct a historical account of the continents. The most basic question asked by de Luc was,

> Why does the earth have mountains? – Such is the question from which I shall here set out, as, in my own private researches, which have never been intermitted, I set out from it forty years ago; and before I can resolve this

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Cambridge University Press, 1992), 204; Matthew Edney, "Reconsidering Enlightenment Geography and Map Making: Reconnaissance, Mapping, Archive," in *Geography and Enlightenment*, eds. David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999), 177; Janet Browne, "Botany in the Boudoir and Garden: The Banksian Context," in *Visions of Empire: Voyages, Botany, and Representations of Nature*, eds. David Philip Miller and Peter Hans Reill (Cambridge: Cambridge University Press, 1996), 164.

[145] Saussure, "*Discourse Préliminaire*."

[146] H.B. de Saussure, quoted in Geikie, 183.

[147] Alexander von Humboldt, *Cosmos*, Vol. 1, 304.

> question, I shall have run through the whole field of natural knowledge, as far as I am master of it.[148]

While de Luc knew of the existence of mountains across the globe, and even the scientific accounts of his colleagues (M. Pallas in Siberia, Dolomieu in the Tyrol, Ramond in the Pyrenees), it was the Alps that received his unmatched attention. In his later travels, de Luc ventured through the lowlands, the North Sea and England, but the Alps remained at the fore of his theory and heart. Nor were the Alps of value to only the geologist as the breadth of science was required to decipher the mountains.[149] Here, chemistry figured predominantly: "It is, I repeat, chiefly our advances in chymistry [sic] which have led to this general conclusion, whence at length has resulted a solid base in geology, and which, by furnishing us with sound general principles, have opened the way to new discoveries."[150]

With respect to geology, the Alps' most valuable assets were their rock strata and the sheer magnitude of all alpine phenomena. Both neptunism and plutonism – debating the origin of mountains - insisted that the rock strata underwent some form of vertical dislocation, presenting themselves to any intrepid geologist willing to venture into the heart of the Alps:

> It is in the mountains, those pyramids which rise upon our plains, that we see more clearly the succession of the strata…which are chiefly observable towards the centre of the great chains of mountains, and to which our observation with respect to times past is limited.[151]

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[148] De Luc, *Letters on the Physical History of the Earth*, 3.
[149] Cecil Schneer, "Introduction," in *Toward a History of Geology*, ed. Cecil Schneer (Cambridge: MIT Press, 1969), 11.
[150] De Luc, *Letters on the Physical History of the Earth*, 94; Anders Lundgren, "The Changing Role of Numbers in Eighteenth Century Chemistry," in *The Quantifying Spirit in the 18th Century*, eds. Tore Frangsmyr, J.L. Heilbron and Robin E. Rider (Berkeley: University of California Press, 1990), 261.
[151] Ibid., 5.

While the plains concealed their rocky strata, inhibiting extensive study, alpine regions offered the geologist the opportunity to observe the terrestrial past and its succession of geological ages. The geologist, called upon to explain this chaotic dislocation, benefited from the succession of strata, which offered a convenient chronological representation of the past. Incidentally, it was Saussure's influence upon de Luc that led to the latter's high estimation of alpine strata and its value as evidence.[152]

Of course, the value of the mountains and their rock strata far surpassed the esoteric ramblings of eighteenth century savants. Certainly for de Luc, the Alps substantiated his system against those of his predecessors or colleagues, but combined with Mosaic history, alpine peaks functioned as the earth's biological repository. Islands in the Noachian sea, the mountain summits offered a superior climate than at present, explaining the presence of tropical fossils in the alpine landscape.[153] As life flowed from the mountains, repopulating the earth following the Deluge, Mosaic history immortalized their sublime role.

Equally important was the ability of all men to venture into the alpine world and observe its geological treasures. Once established as a geological norm, and subsequently as an erudite pastime, the range of individuals pursuing fieldwork stemmed society, encompassing all ages, sexes and social status.[154] Even the most uneducated or acerbic alpine traveler could not fail to observe the overt magnitude of alpine geology:

> I was induced, in the latest of my travels…to give examples of the multiplicity of important phenomena which every man may observe around his own habitation, or in his accidental journies [sic]; and these I have published the first, with the hope that they may excite a taste for such

[152] Ibid., 123.
[153] Ibid., 245.
[154] Martin Rudwick, "Travel, Travel, Travel: Geological Fieldwork," in *The New Science of Geology: Studies in the Earth Sciences in the Age of Revolution* (Aldershot: Ashgate, 2004), 2.

> studies, in themselves very amusing, and may thus every where increase the number of observers.[155]

Fieldwork often called for a multiplicity of instruments and the collection of innumerable specimens, but even the most ill-equipped philosopher could engage the natural world. Travel for de Luc frequently required nothing but a modicum of personal baggage and a notebook. His voyage through the Lowlands to the North Sea was undertaken with only light effects and an open wagon, offering an unobstructed and unhurried view.[156]

Saussure and de Luc carried out the first modern explorations of the Alps, but was their insistence on fieldwork itself innovative? Many of de Luc and Saussure's expeditions coincided chronologically with colleagues, especially their French counterparts. Historiography, however, frequently cites the latter as the true 'creators' of eighteenth century fieldwork and its mountaineering tradition.[157] Both Jean-Étienne Guettard and Nicolas Desmarest, who observed the volcanoes of the Auvergne, have instead been credited with first exploring the mountains, and doing so with an array of instruments. Certainly as early as 1746, Guettard stressed the importance of fieldwork: "Nothing can contribute more toward providing us with a general physical theory of the earth than numerous observations made on the different terrains and the fossils which they contain."[158] Not only did Guettard appear motivated by the economic value of mineralogical fieldwork, it seems questionable whether Guettard's explorations were as

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[155] De Luc, *Geological Travels*, Vol. 3, 507.
[156] De Luc, *Geological Travels*, Vol. 1, 119.
[157] Marie-Noelle Bourguet, "Landscape with Numbers: Natural History, Travel, and Instruments in the Late Eighteenth and Early Nineteenth Centuries," in *Instruments, Travel, and Science: Itineraries of Precision from the Seventeenth to the Twentieth Century*, eds. Marie-Noelle Bourguet, Christian Licoppe and Heinz Otto Sibum (London: Routledge, 2002), 11; Kenneth Taylor, "Nicholas Desmarest and Geology in the Eighteenth Century," in *Toward a History of Geology*, ed. Cecil Schneer (Cambridge: MIT Press, 1969), 340; Read, 13.
[158] Jean-Étienne Guettard, "Map Showing the Rocks that Traverse France and England (1746)," in *A Sourcebook in Geology*, eds. Kirtley F. Mather and Shirley L. Mason (London: McGraw-Hill, 1939), 77.

systematic as his Swiss colleagues; frequently relying on the travel accounts of others in lieu of his own observations, Guettard instead represents a segue, albeit one of great importance, between the cabinet and systematic exploration.

For de Luc and Saussure, however, fieldwork represented a purely epistemic goal.[159] Where Humboldt often exposed the more romantic elements of fieldwork, a dualism embracing both the spiritually subjective and meticulously objective, his Swiss colleagues acknowledged the sublime more as an afterthought or benefit of fieldwork. Aesthetics alone offered little epistemic value. "From what has been said," Saussure cautioned the would-be geologist, "it may be readily seen, that the study of geology will not suit the indolent or sensual; for the life of the geologue must be divided between fatiguing and perilous journies [sic], in which he is deprived of almost all the conveniences of life, and the varied and deep researches of the closet."[160] De Luc concurred, advocating the suppression of romantic exaggeration.[161]

As the epistemic value of fieldwork solidified, natural philosophers, especially those in geology, could no longer substitute direct observation with research in the cabinet and the experience of their associates:

> Given the importance of seeing immobile large-scale features at first hand, it is not surprising that certain sites or regions had acquired an almost canonical status among geologists. Ever since the pioneering work of naturalists such as Desmarest, Saussure and Hamilton in the previous century, regions such as the Auvergne and the Alps, and specific features such as Vesuvius and Etna, had come to constitute an almost stereotypical Grand Tour for all geologists with pretensions to be regarded as well-travelled. Such travelers did not mind that these places were far from

[159] Rudwick, *Bursting the Limits of Time*, 42.
[160] Saussure, "Agenda," *Philosophical Magazine* 5 (1799), 221.
[161] De Luc, *An Elementary Treatise on Geology*, 146.

> virgin territory; on the contrary, what put them into the three-star *vaut le voyage* category was precisely that they were *well* known.[162]

Coupled with the progress of alpine literature and aesthetics, the geological fieldwork so ardently emphasized by de Luc and Saussure had finally generated a positive atmosphere for the Alps. Moreover, repetitive and extensive travel by savants, among the Alps and globally, allowed for an unprecedented degree of comparison, the ramifications of which contributed immensely to science. Every journey the geologist undertook possessed some importance, whether specific in purpose or merely to familiarize oneself with the a region; if nothing else, frequent observation regularized the attention and eye of the observer.[163]

If the investigation of large-scale phenomena captured the minds of de Luc and Saussure, conveying their observations was one of the greatest difficulties they faced. A technical challenge of far less significance in the cabinet, for natural philosophers engaging nature in her entirety, communicating their observations required innovative solutions. Rendered into vivid detail and persuasive prose, immovable objects became mobile, creating virtual witnesses whose experience felt real. While a picture may indeed be worth a thousand words, it is unsurprising that de Luc and Saussure's discourse possessed few illustrations. The medium of illustrating, copper engraving, required much skill and great expense, hindering mass-production.[164] Bereft of proxy pictures or the various visual representations so characteristic of Humboldtian science (such as isoline cartography), de Luc instead relied on persuasive prose and *a priori* knowledge

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[162] Rudwick, "Travel, Travel, Travel: Geological Fieldwork," 5.
[163] De Luc, *Geological Travels*, Vol. 1, 114.
[164] Martin Rudwick, "The Emergence of a Visual Language for Geological Sciences," in *The New Science of Geology: Studies in the Earth Sciences in the Age of Revolution* (Aldershot: Ashgate, 2004), 154.

circulating Europe. So sure was de Luc of his ability to eloquently and accurately craft language that in discussing the construction of his pyrometer – an instrument used to measure temperature - he insisted that "I flatter myself, that a description will make this instrument sufficiently understood to render it unnecessary for me to give a figure out it."[165] Not only could prose accurately convey the assembly of his instruments, but his descriptions seemingly enabled rigid standardization: "Every part of the Instrument being thus determined, it will be easy to construct it every where in a uniform manner."[166]

Conversely, the disadvantages of de Luc's prolixity are readily apparent to the reader. Rebuking colleagues who restricted the detail of their observations to prevent tediousness, which ostensibly resulted in generalization and hypothesis, de Luc's verbosity wears thin on his reader.[167] This challenge of identifying a suitable degree of precision was faced by all natural philosophers. Where de Luc required extensive prose to supplant visual representation, explicitly justifying his rationale, Humboldt struggled to grasp expository length:

> The subject before me is so inexhaustible and so varied, that I fear either to fall into the superficiality of the encyclopaedist, or to weary the mind of my reader by aphorisms consisting of mere generalities clothed in dry and dogmatic forms. Undue conciseness often checks the flow of expression, whilst diffuseness is alike detrimental to a clear and precise exposition of our ideas.[168]

For de Luc, only "diffuseness" could lead to complete exposition and the advancement of science. In achieving this objective, however, the ensuing prose is so repetitive and tedious that de Luc's assertions are often lost. His colleagues assessed his work in a

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[165] Jean-André de Luc, "An Essay on Pyrometry and Areometry, and on the Physical Measures in General," *Philosophical Transactions* 68 (1778), 428.
[166] Ibid., 523.
[167] De Luc, *An Elementary Treatise on Geology*, 74.
[168] Alexander von Humboldt, *Cosmos*, Vol. 1, 1.

similar fashion. Told that his paper on the dry pile was too long to be read at a meeting of the Royal Society on 30 May 1808, the paper was likewise rejected by the Society's journal, *Philosophical Transactions*.[169] Nonetheless, for the discerning reader, the degree of precision achieved by de Luc in his prose is itself a remarkable feat. And though de Luc and Saussure struggled to communicate their work to readers or colleagues, each fundamentally understood that persuasive prose or proxy illustration were an inadequate substitute for direct experience.[170] Only firsthand observation could provide the natural philosopher with the necessary tools to advance science, implicitly inducing greater travel through the Alps.

If fact and observation became the principal elements of de Luc and Saussure's methodology, precision functioned as an accomplice. Observation, by itself, could not provide sufficient facts to form systems or elucidate terrestrial phenomena. Instead, precision served as a vehicle for knowledge and symbol of credibility.[171] The business of the physical sciences was to collect facts, yet errant accumulation offered the natural philosopher poor data. "It was the work of Mr. Playfair," de Luc asserted, "which made me sensible in how great a degree precise and numerous details were necessary for the determination of true general phenomena."[172] Humboldt echoed de Luc's concerns, believing a few precise measurements outweighed a wealth of haphazard observations:

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[169] Willem Hackmann, "The Enigma of Volta's "Contact Tension" and the Development of the "Dry Pile,"" in *Nuova Voltiana: Studies on Volta and His Times*, eds. Fabio Bevilacqua and Lucio Frenonese (Milan: Hoepli, 2000), 108.

[170] Martin Rudwick, "Geological Travel and Theoretical Innovation: The Role of 'Liminal' Experience," *Social Studies of Science* 26, No. 1 (1996), 144.

[171] Michael T. Bravo, "Precision and Curiosity in Scientific Travel: James Rennell and the Orientalist Geography of the New Imperial Age (1760-1830)," in *Voyages and Visions: Towards a Cultural History of Travel*, eds. Jaś Elsner and Joan-Pau Rubiés (London: Reaktion Books, 1999), 175.

[172] De Luc, *Geological Travel*, Vol. 2, 1.

"Inaccurate and imperfect observations have led by false inductions to the great number of physical views that have been perpetuated as popular prejudices among all classes of society."[173] Combining accurate observation with alpine fieldwork, precision was not the brainchild of either de Luc or Saussure. Indeed in his youth, Saussure received Albrecht von Haller's reproach for his over-zealous observation. "I fear, eager as you are," Haller suggested to Saussure, "that on your excursions you walk a little too quickly; one ought to go as slowly as possible, and above all on the alps to sit down from time to time, even to lie down, so as to get a close view of the growing plants."[174] Nonetheless, as the religion of empiricism transcended the natural histories of the late-Enlightenment, precision generated systematic scientific standards.[175] Precision functioned to dichotomize true natural philosophers seeking specific knowledge of the terrestrial world from wealthy and educated savants with merely a passing interest in natural philosophy. Precision, in short, acted as a litmus test reflecting the professionalization and specialization of the physical sciences.

The mark of a true professional was not whether he could provide objects of curiosity or engaging narratives, but rather investigate terrestrial phenomena that contributed to the new empirical science. Explicating the history and evolution of precision, Michael Bravo suggests that the seemingly paradoxical and uneasy relationship between precision and curiosity represented a conflict between creativity and self-disciplined focus.[176] Certainly the plethora of alpine travel accounts that emerged in the

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[173] Alexander von Humboldt, *Cosmos*, Vol.1, 17; Alexander von Humboldt, "Extract of a Letter from M. von Humboldt to Lalande," *Philosophical Magazine* 11 (1801), 356.

[174] Freshfield, 67.

[175] Jaś Elsner and Joan-Pau Rubiés, "Introduction," in *Voyages and Visions: Towards a Cultural History of Travel*, eds. Jaś Elsner and Joan-Pau Rubiés (London: Reaktion Books, 1999), 51.

[176] Bravo, "Precision and Curiosity in Scientific Travel," 164.

eighteenth century focused on curious subjects that could hold the attention of the public, neglecting the often tedious work required to form a solid scientific foundation. Saussure's companions, unwilling to invest the time and precision needed to thoroughly observe the Alps, served as a constant distraction to their colleague. For the astute natural philosopher, however, precision offered the opportunity to surpass the mediocre observations of the casual observer or adventure-seeker:

> I realize that my work can only gain any value by the thoroughness of my investigations. Journeys have been made for more interesting objects, journeys more fatiguing, more dangerous, and more remarkable. What can I have to describe which has not been seen on a greater scale in the Cordilleras and elsewhere? What is wanted is a series of thoroughly carried out investigations into the causes of low temperatures in the upper layers of the atmosphere, on electricity, on the chemical composition and the formation of mountains, on vapours, meteors, plants, animals.[177]

To keep pace of scientific progress and prevent redundancy, Saussure even learnt German to read Gottlieb Sigmund Gruner's *Eisgebirge des Schweizerlandes* (1760).[178] At the same time, de Luc and Saussure's determination to utilize and persuasively advocate thorough investigation aided not only the emerging empiricism, but forced their colleagues to follow suit, even if only to keep pace of methodological developments or propose counter-arguments and theories.

The historian should not dismiss curiosity in the face of the emerging empiricism. In opening the high Alps, precision and curiosity worked synergistically, their fates interconnected as each paved a route for the other in a cyclical relationship that linked natural philosophy and the public. Where curiosity waned, the creativity it offered late-Enlightenment natural philosophy was quickly replaced with the intellectual desire for the

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[177] Letter from Saussure to Charles Bonnet, quoted in Freshfield, 124.
[178] Candolle, 98; Sonntag, 30.

sublime. Meticulous work was paramount, but the subjective remained an integral aspect of late-Enlightenment and Romantic science; one need not look further than Humboldtian science to appreciate the interconnection of empiricism, accuracy and the self.

Acting as a gauge of the natural philosopher's commitment to scientific progress, accurate observation offered a means of verification. The epistemic value of verification, so central to science, allowed de Luc and Saussure to bear witness to the quality of their colleagues' work. Certainly de Luc's respect for Saussure was in large part due to the precision of the latter's observations. Yet the ability to corroborate Saussure's observations equally promoted scientific progress. By directly promoting an increase in scientific travel through the Alps.[179] Playfair's speculation and de Luc's critical response prove informative in this respect, for by the late eighteenth century, no geologist could hazard an ostensibly factual geological theory without firsthand experience.

Ultimately, scientific travelers depended upon precision as a means of imbuing credibility within their own work.[180] De Luc's oeuvre does exactly this, invoking a language almost overbearing in its exploitation of precision and accuracy. Not surprisingly, de Luc's insistence on the credibility of his work was no doubt amplified by the theological message permeating his discourse. If history has all but ignored the merits of de Luc's meticulous prose, his colleagues admired the care he took to relay verifiable and accurate observation. Despite the mutual hostility between de Luc and John Playfair, the latter offered de Luc high praise for his insistence on precision. The passage, worth quoting at length, does much to elucidate de Luc's character and science:

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[179] De Luc, *An Elementary Treatise on Geology*, 159.
[180] Bravo, "Precision and Curiosity in Scientific Travel," 165.

> It sets, however, in a strong light, the inconsistencies that may be observed in the intellectual character of the same individual, to consider that the author of this strange and inconsistent reverie is, nevertheless, an excellent observer, and well skilled in experimental inquiries. It will hardly be believed that he who writes the history of the earth before the formation of the sun, is versed in the principles of inductive reasoning; and that he has added much to the stock of geological knowledge, having observed accurately, and described with great perspicuity and candour. His *Lettres Physiques* are full of valuable and just observations, though accompanied with reasonings that do not seem always entitled to the same praise; and in another work he has succeeded where many men of genius had failed, and had made considerable improvements in a branch of mathematics, without borrowing almost any assistance from the principles of that science.
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> In one respect, the geological writings of [Richard] Kirwin are far inferior to De Luc's: They are evidently the productions of a man who has not seen nature with his own eyes; who has studied mineralogy in cabinets, or in books only; but who has seldom beheld fossils in their native place.[181]

Precision Instrumentation: A Portable Philosophical Cabinet?

With natural philosophers venturing into the Alps, a feat attributable to de Luc and Saussure, minute measurements served to establish the fundamental importance of precision. In practice, the typically reproducible nature of accurate observations offered natural philosophers the ability to detect discreet elements of nature and simplify what was otherwise a complex whole.[182] Understanding the complex interactions of terrestrial phenomena thus required precise, reproducible observation that only collaborative fieldwork could permit; few could hope to build empirical science upon a shaky foundation. Where else then, but to standardized instrumentation, could de Luc and Saussure turn in their struggle to modernize the physical sciences? Here too, the specific

[181] Playfair, 480-82.
[182] Bourguet, 107.

instrument-intensive field of meteorology must be considered, for as the most active meteorological theorists of the eighteenth century, their work in this discipline is arguably their greatest legacy.[183]

The use of instruments was not itself new to science, but their incorporation in the field, especially in the Alps, most certainly was, linking science, travel and accelerating progress.[184] Their work as geologists required nothing but perhaps a hammer and acute eyesight, yet forays into meteorology called for an extensive list of instruments and experiments. If their laboratory was the Alps, de Luc and Saussure traversed it, at a minimum, with a hygrometer (measuring humidity), thermometer, barometer, rock hammer and chisel, and finely tuned eyes.[185] Ranging from measurements of static electricity, altitude and the intensity of the alpine sky, de Luc and Saussure's meteorology resulted in numerous trips to the Alps' highest peaks. Aside from providing yet another reason for fieldwork in remote alpine regions, instruments revealed veiled phenomena. With accuracy an overriding feature of meteorology and instrumentation, like fieldwork, it soon became commonplace among all physical sciences. By the late-Enlightenment, scientific travel emphasizing accurate measurement represented a new "emblem for

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[183] W. E. Knowles Middleton, *Invention of the Meteorological Instruments* (Baltimore: Johns Hopkins Press, 1969), 287. In a brief biography of Saussure for the *Philosophical Magazine* at his death, Candolle claims Saussure's *Essays on Hygrometry* (1783) were the best that came from his pen and fully established his reputation as a philosopher.

[184] Marie-Noelle Bourguet, Christian Licoppe and Heinz Otto Sibum, "Introduction," in *Instruments, Travel, and Science: Itineraries of Precision from the Seventeenth to the Twentieth Century*, eds. Marie-Noelle Bourguet, Christian Licoppe and Heinz Otto Sibum (London: Routledge, 2002), 1.

[185] For a detailed study of meteorological instruments and their role in Enlightenment science, see Jan Golinski, "Barometers of Change: Meteorological Instruments as Machines of Enlightenment," in *The Sciences in Enlightened Europe,* eds. William Clark, Jan Golinski, and Simon Schaffer (London: University of Chicago Press, 1999) and Theodore S. Feldman, "Late Enlightenment Meteorology," in *The Quantifying Spirit in the 18th Century*, eds. Tore Frangsmyr, J.L. Heilbron and Robin E. Rider (Berkeley: University of California Press, 1990).

progress," and the regularity standardized instruments exposed paved a road towards collaboration, corroboration and global interconnection.[186]

The greatest challenge befalling natural philosophers was the construction of instruments or formulae that reduced measurements to meaningful equivalents. Given the significant variations between instruments constructed in different countries, establishing a common scale unanimously accepted by philosophers globally was of integral importance.[187] Standardization, however, was no easy feat to achieve in eighteenth century meteorology. Before calls of standardization rang through the physical sciences, instruments, often named for their designer, were the creation of skilled artisans. Credibility, directly linked to the user, represented trust in an individual as opposed to confidence in the apparatus itself; unable to provide meaningful corroborative data, knowledge remained local,.[188] To achieve the connection of global phenomena desired by late-Enlightenment science, instruments required standard construction and use. Providing value-laden equivalent measures, only when standard measures existed could natural philosophers propose general physical laws.

For de Luc and Saussure, each trying to construct the quintessential instrument single-handedly, precision remained an ultimate goal. Visiting Chamonix in 1754, the difficulties of barometric and trigonometric altimetry forced de Luc to reconsider the

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[186] Ibid., 1-3.
[187] Jean-André de Luc, "Barometrical Observations on the Depth of the Mines in the Hartz. By John Andrew de Luc, F.R.S. in a Letter to Sir John Pringle, P.R.S.," *Philosophical Transactions* 67 (1777), 406; Horsley, 228. Horsley spent much time reducing de Luc's meteorological measurements and formulae to English units.
[188] Christian Licoppe, "The Project for a Map of Languedoc in Eighteenth-Century France at the Contested Intersection between Astronomy and Geography: The Problem of Co-Ordination between Philosophers, Instruments and Observations as a Keystone of Modernity," in *Instruments, Travel, and Science: Itineraries of Precision from the Seventeenth to the Twentieth Century*, eds. Marie-Noelle Bourguet, Christian Licoppe and Heinz Otto Sibum (London: Routledge, 2002), 60-3.

methodological and theoretical foundation of meteorology.[189] Mutually respectful of the other, the following decades witnessed a perpetual contest between de Luc and Saussure for the design of accurate instrumentation. Their respective hygrometers prompted much animosity as each sought to reject the results of the other, asserting the erroneous use or calibration of the offending instrument.[190] Each emphasized fault within the instrument as well as a perceived lack of disinterest by its operator. This contest degenerated into a petty dispute as each ardently defended their own hygrometer. Publishing his criticism of de Luc in the *Observation sur la Physique* (1787) and simultaneously forwarding it to Sir Joseph Banks, Saussure called de Luc's apparatus "vicious and misleading."[191] Science has since proven Saussure's hygrometer superior, but his public criticism deeply offended de Luc, who reproached his compatriot. De Luc was unable to procure equivalent results amongst his own hygrometers, however, he believed the data recorded by his instruments could be weighed against Saussure's: "If the comparative points of those instruments could be determined in the whole extent of their scales, the only inconvenience of their being both used would be, the necessity of reducing to one of them, the observations made with the other."[192]

Conversely, in an essay prepared in 1778 on pyrometry and areometry, de Luc acknowledged that the chasm created by inconsistent instrumentation to be too large to bridge without discontinuing his work until a suitably exact apparatus could be

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[189] Gavin de Beer, "The History of the Altimetry of Mont Blanc," *Annals of Science* 12, No. 1 (1956), 9; Gavin de Beer and Max H. Hey, "The First Ascent of Mont Blanc," *Notes and Records of the Royal Society of London* 11, No. 2 (1955), 246; George Shuckburgh, "Observations Made in Savoy, in Order to Ascertain the Height of Mountains by Means of the Barometer; Being an Examination of M. de Luc's Rules Delivered in his *Recherches Sur Les Modifications de l'Atmosphere*," *Philosophical Transactions* 67 (1777), 513.
[190] Jean-André de Luc, "A Second Paper on Hygrometry," *Philosophical Transactions* 81 (1791), 392.
[191] Middleton, 106.
[192] Ibid., 389.

constructed.[193] Unable to construct his pyrometer with the "exactness of which it is capable," de Luc laboured to recognize and avoid the irregularities besetting his instruments. Saussure likewise expended much effort analyzing the inconsistencies of his instruments in order to improve their accuracy.[194] Old instruments, while offering the meteorologist a certain sense of nostalgia, were ultimately useless because of their irregularity.[195] De Luc admonished the tendency of early-Enlightenment natural philosophers to be content with inaccurate instruments that merely exposed phenomena: "Progress made towards perfecting them [instruments], are the most effectual steps which have been made towards the knowledge of nature."[196] Accurate measurement indicated progress, contributed to the simplification and comprehension of causal relationships and supplied a tool to counter hypothesis and speculation.

Of course, accuracy entailed more than precise or standardized instrumentation: it required repeatability. If de Luc and Saussure's alpine voyages sought to expose unknown phenomena, each likewise spent much time repeating past experiments to verify earlier results; only repetitive observation could separate truth from falsity.[197] Each typically attempted to reproduce experimental results elsewhere, choosing to do so in hopes of eliminating error as well as investigating geographically diverse phenomena. Intending to repeat his observations on the dryness of mountain air, de Luc carried his hygrometer to the top of the Harz, where unsurprisingly, the instrument "fell out, as it often does on mountains."[198] Failure prompted additional voyages until a sufficient

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[193] De Luc, "An Essay on Pyrometry and Areometry, and on the Physical Measures in General," 423.
[194] F.W. Murhard, "Description of M. de Saussure's Diaphanometer," *Philosophical Magazine* 3 (1799), 378.
[195] De Luc, "An Essay on Pyrometry and Areometry, and on the Physical Measures in General," 440.
[196] Ibid., 485.
[197] Sonntag, 36.
[198] Sonntag, 420. Jean-André de Luc, "On Evaporation," *Philosophical Transactions* 82 (1792), 415.

degree of regularity could be established, at which point de Luc deemed the instrument exact enough to offer the physical sciences valuable measurements. For Saussure, repeatability and standardization meant more than repetitive experimentation. Instead, employing family and colleagues to record equivalent measurements, Saussure registered comparable data. With his son stationed at the Priory of Chamonix and his colleague Senebier in Geneva, both completing corresponding experiments with the hygrometer, barometer and cyanometer, Saussure procured comparable measurements that enabled him to verify and extrapolate his own results.[199]

Where these meteorological pursuits required a battery of instruments and experiments to be performed on Europe's highest peaks, the geological work of de Luc and Saussure demanded far less equipment. The difficulty of transporting a plethora of instruments through the Alps often entailed large processions of porters, which in turn required extensive networks and planning to undertake.[200] Gavin de Beer has argued it is precisely for this reason that Saussure's ascent of Mont Blanc overshadowed Paccard's. Ascending only with Balmat and few instruments, Paccard's achievement was easily eclipsed by Saussure's sensationalized ascent in which he was accompanied by a servant, eighteen guides, a tent and a portable stove.[201] Conversely, geological observation could be done with little but acute eyesight and perhaps a rock hammer. Indeed many geologists preferred the serenity of solitary walks through the mountains to large-scale excursions with colleagues or porters. As a youth ambling the mountain paths of the Salève or the

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[199] Thomas Martyn, *An Appendix to the Sketch of a Tour through Swisserland, Containing a Short Account of an Expedition to the Summit of Mont Blanc, by M. de Saussure, of Geneva* (London: G. Kearsley, 1788), 118.
[200] Bravo, "Precision and Curiosity in Scientific Travel," 168; Middleton, 287.
[201] De Beer and Hey, 243. Paccard was further criticized by the Reverend Thomas Brand, who characterized Paccard's journey as entirely useless for its lack of instrumentation.

Voirons, Saussure cherished the freedom of observation only solitude could provide.[202] To the natural philosopher overwhelmed by instruments, the enjoyment of leisurely travel with nothing but an observant eye and notebook reflected science at its purest.

Saussure's colleague, Louis Ramond de Carbonnières, author of *Observations faites dans les Pyrénées pour servir de suite à des observations sur les Alpes* (1789), emphasized the solitary mountaineer's unmediated encounter with nature to an even greater degree, initially rejecting most instruments but the perceptive eye.[203] For Ramond, the human observer functioned as a reliable equal to the emerging precision instruments of de Luc and Saussure. Armed with proficient observational skills acquired through years of scientific travel, Ramond ventured into regions few voluntarily wished to pass. "Being the only one of the three attracted to these heights from choice," Ramond writes, "I should naturally have been the first to reach the appointed rendezvous, and in fact I had to wait there for my guides."[204] Continuing, Ramond stressed the pleasure solitary fieldwork offered the explorer heroic enough to walk uncharted territory:

> Alone, and in a spot which the foot of man had never trodden, arrived at a height which reminded me of that of the Alps, and the time when I passed them, in face of heaven which from the height of their summits I had never seen otherwise than serene, but which rarely had smiled upon me on the top of the Pyrenees, and in a silence, interrupted only from time to time by the passing wind, I seemed to command the world.[205]

Incidentally, two decades after his work in the Pyrenees, Ramond eventually conceded to the prevailing empiricist mentality and so too traveled with an array of instruments.[206]

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[202] Freshfield, 54.
[203] Bourguet, 99.
[204] Louis-François Ramond de Carbonnières, *Travels in the Pyrenees* (London: Longman Hurst Rees Orme and Browne, 1813), 267.
[205] Ibid., 272.
[206] Bourguet, 113.

Ramond never truly renounced his earlier outlook, however, and his proto-romantic attitude towards observation gathered strength in the approaches of Goethe and Humboldt.

A Symbiotic Relationship: Decontextual and Local Knowledge

With instruments and fieldwork promoting empiricism, precision and standardized scientific knowledge, the stage was set for an integral component of alpine knowledge: decontextualization. Where knowledge before the eighteenth century rested upon individuals or archival sources, the new empiricism depended upon precision instrumentation, and so data recorded by a standardized apparatus suddenly became comparable.[207] Observations and instruments, regardless of their displacement globally, could be analyzed by anyone, anywhere, permitting the data to travel. The ensuing result was a cultural shift that, in Foucauldian discourse, emphasized instruments as a "technology of power" over textual accounts.[208] Paradoxically, the ability of so few to provide data to so many did not suppress the rising tide of fieldwork, as philosophers still competed for firsthand observations. Rather, fieldwork expressed through persuasive prose, devoid of informative visual representations or measurements faded in the face of the quantitative assault. The epistemological ramifications for the physical sciences were unfathomable as knowledge was decontextualized, ready to be scrutinized by natural philosophers across Europe. As knowledge of local particulars around the globe gained mobility, stability and combinability, a Latourian "cycle of accumulation" developed, in

[207] Marie-Noelle Bourguet, Christian Licoppe and Heinz Otto Sibum, 8.
[208] Ibid., 11.

which scientific expeditions both drew upon and contributed to the larger body of knowledge.[209] De Luc and Saussure, the most zealous alpine philosophers, represented the center of this body of knowledge with respect to the Alps, accumulating and subsequently disseminating their work across Europe.

The process of decontextualizing knowledge was certainly an ambition of de Luc and Saussure, but they were nonetheless fortunate to be affiliated with like-minded colleagues. Savants remained deeply dependent upon local experts, since terrestrial phenomena were typically local in character, but it was the cosmopolitan background of wealthy savants that allowed analysis and dissemination of theories that expanded science.[210] Concentric networks throughout the republic of letters offered both de Luc and Saussure a forum to exchange ideas and contact local savants and guides. Even though each sensationalizes various aspects of their travels, it is impossible to ignore the role played by local guides or benefactors. Moreover, interactions with locals permitted the discovery and examination of remote regions, a feature that the absolute knowledge of standardized instruments could not provide.[211] Whether offering provisions or board, advice pertaining to specific routes for ascending unknown peaks, or merely serving as porters, the expeditions of cosmopolitan savants required knowledge of geographical regions only locals possessed. Traveling through the Low Countries towards the North Sea, de Luc's network provided him with either acquaintances or letters of

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[209] David Philip Miller, "Joseph Banks, Empire, and "Centers of Calculation" in Late Hanoverian London," in *Visions of Empire: Voyages, Botany, and Representations of Nature*, eds. David Philip Miller and Peter Hans Reill (Cambridge: Cambridge University Press, 1996), 23. See also the last two chapters of Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987).
[210] Rudwick, *Bursting the Limits of Time*, 32.
[211] Michael Bravo, "Ethnographical Navigation and the Geographical Gift," in *Geography and Enlightenment*, eds. David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999), 200.

recommendation he could use to contact well-informed men. At Malchin, a small town in the Duchy of Mecklenburg-Schwerin, a letter of recommendation for the Privy Counselor Heckler was sufficient for the procurement of a guide. Such guides proved essential for on more than one occasion, de Luc owed his life to his quick thinking and knowledgeable guide for saving him from peat bogs or worse.[212] With Haller's introduction and recommendation carrying significant authority, Saussure likewise exploited the networks available to him.[213]

Though the transfer of knowledge across these networks appeared unidirectional, it was not, as individuals with only local knowledge could not extrapolate geographically limited phenomena into comprehensive systems. Local knowledge was an indispensable, but ultimately subordinate aspect of the power relationship with standardized instruments. Only a natural philosopher well traveled and versed in the physical sciences could compare and contrast diverse observations and simplify them into general laws.[214] De Luc and Saussure both make frequent reference to the limits of local knowledge, and equally important, the typical apathy towards scientific investigation. "I have known inhabitants of the Alps, who," Saussure insisted, "not knowing how to explain the origin of these ridges, said that the ice pushed up and thrust to the surface all foreign bodies found in its interior."[215] Recalling de Luc's exploration of the Buet, Marc-Theodore Bourrit divulges the difficulty de Luc experienced in attempting to gain knowledge of the mountain:

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[212] De Luc, *Geological Travels*, Vol. 1, 176-9.
[213] Sonntag, 24.
[214] Martin Rudwick, "Travel, Travel, Travel: Geological Fieldwork," 4.
[215] Horace-Benedict de Saussure, "Alpine Geology (1787)," in *A Sourcebook in Geology*, eds. Kirtley F. Mather and Shirley L. Mason (London: McGraw-Hill, 1939), 121.

> He endeavoured then to inform himself of the name of the mountain, the place where it was situated, the road necessary to be taken to arrive at it, and whether or not it was to be ascended; but no person could be found that knew it, nor could he gain the least intelligence with respect to any of his questions; he was obliged therefore, at all events, to take a journey in search of it and endeavour to find it himself.[216]

Had de Luc's misfortune ended there, he might have considered himself lucky. His guide, an apprentice hunter with no interest in science, "fatigued with the labour he had undergone and in a fit of laughter at the folly of taking all this trouble to boil a little water, he threw himself, unluckily, with all his weight on Jean De Luc's foot and badly sprained it."[217] Saussure faced a similar predicament as fear of the cold silence and unknown troubled even his own guides on his triumphant ascent of Mont Blanc.

These anecdotes in mind, it is clear that the transfer of knowledge operated within a reciprocal relationship between the local and the decontextual. The confluence of these components was necessary for alpine knowledge to flow across Europe; one could not function without the other. Where ancient prejudices or intellectual apathy prevented local exploration, and savants lacked the knowledge to safely ascend Europe's highest peaks, together, they enabled the dissemination of the alpine world. Coupled with the emergence of a bourgeois culture and the institutional cultivation of science, a genuine interest in science arose, both popularizing it and serving as a catalyst for further study.[218] With an eager public devouring travel narratives, and colleagues scouring their scientific tracts and measurements, the ideas of de Luc and Saussure gained currency in the late-Enlightenment surge for far-reaching and combinable knowledge. With respect to the

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[216] Marc-Theodore Bourrit, *A Relation of a Journey to the Glaciers: In the Dutchy of Savoy* (Norwich: R. Beatniffe, 1775).
[217] Tunbridge, 16.
[218] Porter, *The Making of Geology*, 94.

Alps, much of the knowledge the Swiss had long since been aware of was no longer relegated to languish in the work of local philosophers or the practical knowledge of hunters. One doubts whether either de Luc or Saussure intentionally sought to alter European perceptions regarding the Alps, for their interests appear linked to scientific expansion rather than aesthetics. Yet their insistence upon factual observation and fieldwork synergistically merged with a curiosity for travel, a literary movement that recognized the intrinsic value of nature, and the institutionalization of science. And yet, where both insisted on fact over feeling, neither de Luc nor Saussure could ignore either the magnificence of the Alps or the flood of sublime aesthetics crossing Europe.

~~ Chapter 3 ~~

Those Sublime Mountains: Aesthetics in an Age of Empiricism

By the mid-eighteenth century, the emotional experience associated with alpine scenery became increasingly sensationalized and sought after, especially among Europe's literary elite. The response was not unanimous, for even in the waning years of the century, some nonetheless perceived monotony where others saw sublimity.[219] But as the work of Edmund Burke, Immanuel Kant and the German romantics gained exposure and precedence, the exception of alpine sublimity changed to the rule. Indeed by the 1780s, Rosalie de Constant could remark that,

> It was only about this period that the gigantic nature by which we are surrounded began to be admired. Travelers from a distance came to Geneva in order to make the trip to Chamonix, which had only recently become known. Nothing can show more clearly the influence of fashion. It might seem that the great immovable mountains had only become noticeable since the observations and travels of Monsieur Saussure.[220]

Reflecting the many facets of the transition towards "mountain glory," if one momentarily ignores Saussure's role, Rosalie de Constant's observation emphasizes the sensationalism with which Europeans approached the sublime magnitude of the Alps. This aesthetic appreciation, a byproduct of de Luc and Saussure's rigorous fieldwork, was

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[219] Devonshire, 89.
[220] Freshfield, 26.

by no means an intended outcome, but the confluence of their work and Europe's emerging intellectual and cultural climate instigated an aesthetic revolution. Alexander von Humboldt's sensationalized equinoctial travels, representing an evolution of alpine science, expanded upon the methodology and aesthetics of de Luc and Saussure. This chapter will look at this rise of alpine aesthetics, as well as examine more closely Humboldt's method and how, whether intentional or not, it reflected or continued the work of de Luc and Saussure.

A complete examination of the sublime is too tangential to engage in depth, however, a modicum proves essential to follow the aesthetic mentality of late-Enlightenment European science. Originating in the work of the rhetorician Longinus early in the first millennium, the sublime only gained aesthetic currency in the eighteenth century following John Baillie's 1747 *Essay on the Sublime*. Taking the reigns of the emerging movement, Burke characterized the alpine sublime as a strong passionate or emotional response associated with the astonishment caused by height, vastness, terror and irregularity.[221] If beauty was connected to a qualitative aesthetic assessment of form, the sublime expressed itself quantitatively, a representation of limitlessness that paralyzed the soul through positive terror.[222] Where Burke emphasized terror as a ruling principle, Kant instead broadened his definition to include the noble and splendid sublime. For Kant, the sublime existed in a moral sphere, enhancing the intellect as reason supplied humanity with the power to overcome and dominate the temporary humiliation caused by

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[221] Edmund Burke, *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful: With an Introduction Discourse Concerning Taste, and Several Other Additions* (Montrose: D. Buchanan, 1803), 72.

[222] David Simpson, *The Origins of Modern Critical Thought: German Aesthetic and Literary Criticism from Lessing to Hegel* (Cambridge: Cambridge University Press, 1988), 102; Cliff McMahon, *Reframing the Theory of the Sublime: Pillars and Modes* (Lewiston: Edwin Mellen Press, 2004), 13.

the sublime.[223] Essentially, sublimity existed not in the mountains themselves, but in the minds of people as they measured themselves against nature's omnipotence.

Now, what did this mean for science? How did natural philosophers representing late-Enlightenment science, vitalism and romanticism apply such abstraction in practice? Much of this theory no doubt surpassed either de Luc or Saussure's engagement or interest in aesthetics, but both recognized the intellectual value and enjoyment alpine science offered the explorer. Amidst the seriousness of the scientific traveler's epistemic duty to faithfully record natural phenomena, the aesthetics of observation served as a repose and motivational tool for de Luc:

> I wish to inspire some inclination for observations of this kind; respecting which I can truly say, from long experience, that no study can be more agreeable; for they beguile the weariness of journeys, and even of common walks, affording inexhaustible objects of attentions and reflection.[224]

For Saussure, the pleasure his alpine excursions provided him forever tied his soul to the mountains: "I have had from childhood the most positive passion for the pleasures of the mountains. I still remember the sensation I felt when, for the first time, my hands touched the rocks of the Salève and my eyes enjoyed its point of view."[225] "It became for me a sort of illness," Saussure conceded, "my eyes could not encounter this mountain [Mont Blanc], which one sees from so many spots in our neighbourhood, without my being seized with a pang."[226] When the frosts and occupations of winter prevented journeys to the highest Alps, the spring offered a welcome respite, and a chance to once again engage nature: "able to return to them, the first Alpine plants, the moment that I recognize them,

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[223] Steven Knapp, *Personification and the Sublime: Milton to Coleridge* (Cambridge: Harvard University Press, 1985), 74.
[224] De Luc, *Geological Travels*, Vol. 1, 111-12.
[225] Horace-Benedict de Saussure, ''*Discourse Préliminaire*.''
[226] Saussure, *Voyages dans Les Alpes*, Vol. 4 (1796) § 2023.

always give me a thrill of delight; I feel then that I am in my element, in possession of the liveliest pleasures that the study of nature can give to its lovers."[227] The everyday presence of the high Alps arguably contributed to a tacit acceptance for many who lived in their shadows, ignoring the mountains' aesthetic and scientific value. But for de Luc and Saussure, growing up amidst the sheer magnitude of the Alps inspired them in a way few could appreciate in the mid-eighteenth century.

The passion each felt for the Alps' vastness and value to science exemplified the Kantian sublime; observation simultaneously developed the self and provided science with the factual foundation to obviate error. Aesthetics typically assumed a negligible function in de Luc and Saussure's approaches to science, yet the sublime came to dominate their work at times. Ascending the Crammont for the second time in 1778, Saussure struggled to separate his emotions from scientific objectivity:

> I felt an inexpressible satisfaction in finding myself on this magnificent belvedere…My first object was to revise and complete the notes I had taken in 1774, but I soon found this work distasteful; it seemed to me that it was an insult to the sublimity of the scene to compare it to anything but itself. I began accordingly my observations afresh.[228]

Of course, even the slightest acknowledgment of the subjective breeched the radical separation between mind and matter posited by mechanists.[229] How would either de Luc or Saussure have responded to the allegation that their observations perhaps clouded the distinction between the objective and subjective? In fact, for Saussure, what might be perceived as an aesthetic assessment instead functioned as an important and objective analysis. The complexity of alpine geology and its sheer magnitude often precluded far-

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[227] Ibid., Vol. 1 (1779), §508.
[228] Ibid., Vol. 2 (1786), §909-919.
[229] Reill, "Anthropology, Nature and History in the Late Enlightenment: The Case of Friedrich Schiller," 245.

reaching investigation, but upon reaching the summit of Mont Blanc, the view from the top offered him a comprehensive panorama. Bourrit, communicating the very importance of this viewpoint, suggests its value to Saussure: "He could now make himself master of their relations, their connection, their structure; and one view cleared up what years of labour had not been able to solve to his satisfaction."[230] Despite the personal satisfaction fieldwork offered the compassionate alpine explorer, one senses both de Luc and Saussure would have adamantly contested any such accusation, insisting their work to be founded purely on observation. However, sublime aesthetics offered these astute natural philosophers another dimension to connect with their readers. Using picturesque descriptions to secure their readers' attention, their prose could subsequently bombard the scientific community with their actual purpose: the development of geology, meteorology and scientific methodology. Whether either was indeed cunning enough to pursue this scheme is unknown, but if not, serendipity smiled fortuitously upon de Luc and Saussure and did so regardless.

Refining the Alpine Sublime: Humboldtian Science

While de Luc and Saussure emphasized the primacy of fact over feeling, their successors, most notably Alexander von Humboldt, blurred this distinction. The basic tenets of Humboldtian science insisted upon rigorous observation and quantification, but at the same time it concluded the late-Enlightenment attack against mechanistic dualism. Believing the physical world was mirrored in the human mind, Humboldt attempted to

[230] Martyn, 110.

unite quantification with poetic description.[231] His purpose was two-fold: he sought to uncover the interrelation of natural phenomena and in doing so, acknowledge nature's role as a repository of morality. Understanding nature proved essential to understanding humanity. With the secularization of science, the study of nature emerged as a new tool to furnish a path to the self.[232] Humanity was inextricably immersed in the natural world and the acknowledgement of this was necessary for science to continue to develop beyond the limits of mechanism. In the words of Wilhelm von Humboldt, "one must always contemplate man, even in his loftiest endeavors, as a whole product of nature, one whose sides he shares with the natural world."[233] Wilhelm suggested that if humanity developed in relation to the natural world, to explore himself deeply, man required a serious investigation of his environment. The teleology Humboldtian science perceived in the natural world was not unlike de Luc's, though Humboldt did not approach nature under the pretext of physicotheology. Each considered the natural or physical world essential to human history, development and morality; true knowledge could only materialize from an intimate investigation of nature's interrelations with itself and humanity.

The extent to which de Luc and Saussure influenced Humboldt is unclear. Barring a perfunctory reference to Humboldt's use of de Luc's hygrometer, there is no significant mention or analysis of de Luc's work. Conversely, Humboldt did hold Saussure in high regard, venerating his *Voyages dans les Alpes* as one of the greatest contributions to science. Ascending the peak of Tenerife, Humboldt attributed his assessment of the sky's

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[231] Reill, *Vitalizing Nature in the Enlightenment*, 27, 241.
[232] Jacques Roger, "The Living World," in *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*, eds. G. S Rousseau and Roy Porter (Cambridge: Cambridge University Press, 1980), 279; Reill, "Anthropology, Nature and History in the Late Enlightenment: The Case of Friedrich Schiller," 244; Richards, 13.
[233] Wilhelm von Humboldt and Marianne Cowan, *Humanist without Portfolio: An Anthology of the Writing of Wilhelm Von Humboldt* (Detroit: Wayne State University, 1963), 101.

intensity to Saussure's cyanometer. Well versed in "Saussurean" discourse, Humboldt even went so far as to mimic Saussure's *Voyages*, providing humanistic elements to engage his readers and blunt the monotonous meteorology and geology.[234] While Humboldt may have been indebted to Saussure, it is clear he did not attribute the most important characteristics of late-Enlightenment science to the latter. Instead, he credited Jean-Louis Giraud-Soulavie, who explored the Vivarais in the 1770s, with this feat, believing Soulavie's combination of fieldwork, meteorological observation and instruments to be the instigating factor in transforming the Enlightenment's dominant scientific and cultural paradigms.[235]

Moreover, where his colleagues praised the Alps for their value to science, Humboldt believed that nature's richest and most varied elements existed in Southern Asia and the New World:

> America offers an ample field for the labours of the naturalist. On no other part of the globe is he called upon more powerfully by nature to raise himself to general ideas on the cause of phenomena and their mutual connection. To say nothing of that luxuriance of vegetation, that eternal spring of organic life, those climates varying by stages as we climb the flanks of the Cordilleras, an those majestic rivers which a celebrated writer has described with such graceful accuracy, the resources which the New World affords for the study of geology and natural philosophy in general have been long since acknowledged.[236]

The northern latitudes, for Humboldt, presented obstacles to the discovery of natural laws due to the excessive complication of phenomena. Humboldt's allegation that the scientific value of the New World outweighed that of the Old World begs the question: Why did

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[234] Ibid., xx. Abhorring writing founded upon "literary stilts," Saussure was criticized by contemporaries for his provincial style that rejected sentimentality and exaggeration.
[235] Bourguet, 111.
[236] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 1, xxi-xxii.

neither de Luc nor Saussure expend the time or energy to investigate the New World? One imagines that in the infancy of geology and meteorology, the Alps supplied sufficient evidence for study. Second, lacking a comparable study of organic life, de Luc and Saussure did not require the biodiversity so essential to Humboldt's work. Furthermore, one must not underestimate either the aesthetic or subjective impulse both felt for the Alps, or the patriotic sentiment of pursuing natural philosophy in Switzerland.

That Humboldt forwent extensive travel in the Alps is unsurprising given his desire for the exotic, the object of his study and the rationale for its location, but the Alps nonetheless featured as an essential point of comparison for his readers. In the years preceding his equinoctial travels, Humboldt took the opportunity to acquaint himself with the Alps, enabling him to compare them with the Andes. Seldom hesitating to compare his observations and phenomena with those of the Alps, on reaching the torrid region, analogy runs rampant in his narrative. In places, this analogy appears to simply provide a frame of reference for the reader: "The road leading from the port of Caracas…resembles, as I have already observed, the passage over the Alps, the road of St. Gothard, and of the Great St. Bernard."[237] Elsewhere, whether observing tropical lakes or the mountain scenery, his aim is aesthetic comparison. Discussing the foot of the Guacharo, Humboldt remarks that "the aspect of this spot is majestic, even to the eye of a traveler accustomed to the picturesque scenery of the higher Alps."[238] Humboldt even went so far as to remark upon an essentially moral feature of global mountains: freedom. Like the Swiss, imbued

[237] Ibid., 387.
[238] Ibid., 255.

with freedom by the Alps, so too did the Indians of the Andes appear free and self-governing.[239]

Given the tenacity with which he draws analogy between geographical phenomena, Humboldt's criticism of comparison appears all the more hypocritical:

> It cannot be too often repeated that nature, in every zone, whether wild or cultivated, smiling or majestic, has an individual character. The impressions which she excites are infinitely varied, like the emotions produced by works of genius…We may institute a parallel between the colossal summit of Mont Blanc and the Himalaya Mountains; the cascades of the Pyrenees and those of the Cordilleras; but these comparisons, useful with respect to science, fail to convey an idea of the characteristics of nature in the temperate and torrid zones.…That which speaks to the soul, which causes such profound and varied emotions, escapes our measurements as it does the forms of language. Those who feel powerfully the charms of nature cannot venture on comparing one with another, scenes totally different in character.[240]

At any rate, Humboldt's frequent comparisons do serve an essential service for a readership unfamiliar with the New World. Assuming even minimal knowledge of the Alps among their readers, neither de Luc nor Saussure faced the same challenge as Humboldt in relating distant observations. Thus, Humboldt's reference to the Alps served to bridge the disconnect created by the Atlantic Ocean, in a sense recontextualizing decontextualized knowledge. Moreover, in spite of European desire for the exotic, by utilizing a familiar object for comparison, Humboldt lessened any intimidation the 'other' caused his reader.

High in the Andes, Humboldt repeatedly emphasized the role of instrumentation and accurate observation. Believing instruments to be an extension of the senses,

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[239] Alexander von Humboldt, "Letter from M.A. Humboldt to C. Delambre," *Philosophical Magazine* 9 (1801), 366.
[240] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 2, 4.

Humboldt sought to use them to compare the relationship between physical and biological phenomena. Where his predecessors approached the mountains with an exclusively descriptive mentality, collecting curious specimens, Humboldt's expedition was characterized by instruments and measurements; never losing sight of the interest of Europe's museums, he did collect extensively, accumulating over six-thousand specimens.[241] But comparison, he believed, was the answer to the epistemic limitations of natural history.[242] So strongly did he insist on comparison that he considered it a more worthy goal than discovering a new species.

Of course, to undertake a journey of such magnitude required a degree of planning and funding unmatched by Humboldt's colleagues. Certainly Saussure stressed the importance of fieldwork guided by a predetermined method of study, but the coordination necessary for a land-based expedition in the New World was unprecedented. "Overpowered at once by a great number of objects," Humboldt remarks, "we were somewhat embarrassed how to lay down a regular plan of study and observation."[243] The mythical status the expedition attained was due to more than a simply heroic or exotic adventure. Whether acknowledged by his colleagues or not, the ability to plan a five year journey and return with forty-two boxes was mind-boggling.[244] Humboldt expressed his gratitude to European governments and his scientific networks for their support, but unlike de Luc or Saussure, who availed themselves of local alpine knowledge and guides wherever possible, Humboldt had little chance for recourse in the field:

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[241] Alexander von Humboldt, "Letter from C. Humboldt to C. Fourcroy," *Philosophical Magazine* 10 (1801), 8.
[242] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 1, x.
[243] Ibid., 173.
[244] Ibid., xii.

> In a country abounding in such magnificent scenery, and at a period when, nothwithstanding [sic] some symptoms of popular commotion, most of the inhabitants seem only to direct attention to physical objects, such as the fertility of the year, the long drought, or the conflicting winds of Petare and Catia, I expected to find many individuals well acquainted with the lofty surrounding mountains. But I was disappointed; and we could not find in Caracas a single person who had visited the summit of the Silla. Hunters do not ascend so high on the ridges of mountains; and in these countries journeys are not undertaken for such purposes of gathering alpine plants, carrying a barometer to an elevated point, or examining the nature of rocks.[245]

Guided by a perception unshaped by memory, Humboldt was forced to establish "new categories of experience" to mobilize observations and measurements that "bore no relation to previous experience."[246] With local subsistence populations possessing little interest or knowledge of natural phenomena, the challenges the equatorial traveler faced were enormous. Local knowledge and scientific networks, so vital to the work of his continental colleagues, instead proved a source of frustration for Humboldt. Moreover, the apathetic response Humboldt perceived among the local population suggests that an intrinsic appreciation of the mountains was by no means an intercultural phenomenon. Where the local populations offered little by way of help, if their ignorance of local phenomena appeared limiting, their curiosity for European science proved a constant distraction:

> Whilst every surrounding object was fitted to inspire us in the most lively interest, our physical and astronomical instruments in their turns excited strongly the curiosity of the inhabitants. We had numerous visitors; and in our desire to satisfy persons who appeared so happy to see the spots of the

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[245] Ibid., 416; Alexander von Humboldt, "Sketch of a Geological Delineation of South America," *Philosophical Magazine* 18 (1804), 26. Humboldt considered the difficulty of the terrain to be partially at fault for the lack of local knowledge: "No Indian is able to clamber up to the top of this mountain [Duida] and the rocks of its summit without a week's labour, because the luxuriance of vegetation in this climate impedes the progress of traveling."

[246] Dorinda Outram, "On Being Perseus: New Knowledge, Dislocation, and Enlightenment Exploration," in *Geography and Enlightenment*, eds. David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999), 285.

> moon through Dollond's telescope, the absorption of two gases in a eudiometrical tube, or the effects of galvanism on the motions of a frog, we were obliged to answer questions often obscure, and to repeat for whole hours the same experiments. These scenes were renewed for the space of five years, whenever we took up our abode in a place where it was understood that we were in possession of microscopes, telescopes, and electrical apparatus.[247]

The challenges these passages relate elevates the impressive nature of the expedition, for bereft of any meaningful local assistance, Humboldt revealed natural phenomena and through innovative visual representation (isoline cartography),[248] disseminated his observations.

Equally, if not more important than the scale of Humboldt's expedition and the development of de Luc and Saussure's methodology, was his insistence that true natural philosophy rest upon aesthetic appreciation.[249] Emphasizing the connection between the natural world and man, Humboldtian science represented a clear break from mechanism and a rather considerable evolutionary leap from the aesthetics of de Luc and Saussure. Where the latter considered the sublime an admirable but extraneous feature of natural philosophy, Humboldt looked to it as a means of unveiling natural phenomena. "Descriptions of nature," Humboldt believed, "may be defined with sufficient sharpness and scientific accuracy, without on that account being deprived of the vivifying breath of

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[247] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 1, 173.
[248] Anne Marie Claire Godlewska, "From Enlightenment Vision to Modern Science? Humboldt's Visual Thinking," in *Geography and Enlightenment*, eds. David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999), 264. Humboldt did not invent isoline cartography, but rather rescued it from obscurity. Able to connect disparate numerical data and enable interpretation, which in turn revealed the association of natural phenomena, Humboldt's isolines functioned as a center of calculation that mobilized measurements.
[249] Reill, *Vitalizing Nature in the Enlightenment*, 243.

imagination."[250] It is, however, questionable whether Humboldt began his research with this concept deeply ingrained, or to what degree it evolved throughout his life.

Above all, Humboldt believed that nature revealed her most veiled treasures, and hence natural laws, to aesthetic perception. Everywhere, Humboldt claimed, nature penetrated the mind and revealed the laws that regulated the universe. Moreover, much like de Luc and Saussure, it was the mountains that provided Humboldt with a plenitude of observations and mental stimulation: "An expedition to the summit of the volcano of Tenerife is interesting, not solely on account of the great number of phenomena which are the objects of scientific research; it has still greater attractions from the picturesque beauties which it lays open to those who are feelingly alive to the majesty of nature."[251] So great was Humboldt's interest in mountains ranges, especially those which remained unexplored, that he planned and equipped himself for a voyage to the mountains of Morocco. Although the journey never took place, the intensity with which Humboldt approached the alpine world and uncharted territory does much to elucidate his character. The geographical range of his exploration certainly far surpassed the alpine world, but for Humboldt, vertical dislocation offered the natural philosopher the ability to observe and compare phenomena varying in elevation.

Emphasizing the sublimity of the mountains, Humboldt valued the quantification of space so characteristic of the sublime:

> There is doubtless something solemn and imposing in the aspect of a boundless horizon, whether viewed from the summits of the Andes or the highest Alps, amid the expanse of the ocean, or in the vast plains of Venezuela and Tucuman. Infinity of space, as poets in every language say,

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[250] Alexander von Humboldt, *Cosmos*, Vol. 2, 438.
[251] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 1, 79.

> is reflected within ourselves; it is associated with ideas of a superior order; it elevates the mind, which delights in the calm of solitary meditation.[252]

Although he had been assessor of mines at Berlin prior to his South American expedition, the continental mountains and the economic significance of mining did little to engage Humboldt's interest. Instead, Humboldt was drawn to distant oceans and the confluence of sea and mountain. The vague and undefined mountains of the New World, he believed, offered more than a panacea for late-Enlightenment science; remote mountains possessed a fascinating power that surpassed the narrow tedium of European life. Moreover, this appeal for exotic mountains produced a rather curious suggestion. Comparing his astronomical observations taken from the northern climates with those procured near the equator, Humboldt perceived the latter to be more distinct and well defined, leading him to believe it was "as if more perfect instruments were employed."[253] The mere fact that the sublime could positively influence perceptions of precision is of course a fascinating proposition.

In the Humboldtian sublime, however, quantification had its limits; the highest peaks not only surpassed their aesthetic value, but conversely reduced it:

> Travelers have learned by experience, that views from the summits of very lofty mountains are neither so beautiful, picturesque, nor so varied, as those from heights which do not exceed that of Vesuvius, Righi, and the Puy-de-Dôme. Colossal mountains, such as Chimborazo, Antisana, or Mont Rosa, compose so large a mass, that the plains covered with rich vegetation are seen only in the immensity of distance, and a blue and vapoury tint is uniformly spread over the landscape.[254]

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[252] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 3, 99.
[253] Alexander von Humboldt, *Personal Narrative of Travels to the Equinoctial Regions of America,* Vol. 1, 351.
[254] Ibid., 80.

The ability of the mind to visually and intellectually grasp the entirety of an aesthetically rich scene proved essential to the Humboldtian conception of sublime nature. Without the aid of the mind, nature could not be appreciated to the same extent. Limiting the parameters of aesthetic value, Humboldt exercised caution in the scope or frequency of his admiration. Excessive reverence equally detracted from the narrative, wearing on a readership that typically desired descriptions of peculiar or distant phenomena.[255] Humboldt yearned for his narrative to be popularly received, creating a tension between his aesthetics and precision. If excessive veneration lessened the value of his narrative, like Goethe, he believed that precision and quantification, though necessary, detracted from the aesthetic and emotionally holistic experience of nature. The response to Humboldt's *Equinoctial Travels* in Europe suggests his narrative overcame this tension, proving to be both aesthetic and precise.

Representing a microcosm where nature in its scientific and aesthetic entirety could be viewed as a harmonious whole, the mountains ultimately assumed a significant role in Humboldtian science. Offering a realm of inner freedom, escape and restoration, Humboldt called for his readers to follow the voice of Schiller: "Freedom is in the mountains!"[256] But like de Luc and Saussure, for Humboldt, the mountains presented the natural philosopher with a unique environment to engage nature in many of her operations. Although Humboldt's expedition did not focus on the Alps, his work in the Cordilleras, must have weighed heavily on the European imagination. From ferocious "tygers" [sic], crocodiles, formidable "moskitos" [sic], ants and scarce provisions,[257]

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[255] Ibid., 79.
[256] Michael Dettelbach, "Global Physics and Aesthetic Empire: Humboldt's Physical Portrait of the Tropics," 272.
[257] Alexander von Humboldt, "Letter from Humboldt to Fourcroy," 4.

Humboldt's sensationalized travels captivated Europe. Jean-Claude de la Métherie, describing Humboldt's travels through the Kingdom of Quito, considered it the most interesting in the world because of the colossal height of its mountains. "They ascended to the height of 3036 toises above the level of the Pacific Ocean," de la Métherie states, "where the blood issued from their eyes, lips, and gums, and where they experienced a cold not indicated by the thermometer."[258] All told, the combination of this highly sensationalized expedition and the rigorous work carried out by de Luc and Saussure brought mountains in general, and the Alps in particular, into the European domain. Coupled with the emerging bourgeois culture, the institutionalization of science, and sublime aesthetics, the Alps emerged as a dominant element of European culture, no longer veiled in desolate obscurity.

[258] J.C. de la Métherie, "Short Account of Travels Between the Tropics, by Messrs. Humboldt and Bonpland, in 1799, 1800, 1801, 1802, 1803, and 1804," *Philosophical Magazine* 21 (1805), 362.

~~ Epilogue ~~

Soon after Saussure's 1787 ascent of Mont Blanc, a small memorabilia industry arose in Chamonix. By no means was alpine tourism a common occurrence, for this would require at least another few decades, but the seeds had been sown. And though the halcyon days of nineteenth century mountaineering were yet a half-century away, no longer did the high Alps present images of dragons and peril, a repulsively monotonous mass devoid of life and value. If the ascent represented the beginning of a new period of geohistory, it was certainly not the first Europe had heard from either Saussure or de Luc. By the age of twenty-four, Saussure had built a reputation known to Chamonix's visitors: "Professor Saussure is not one of those who rely on the report of others. Young and eager to learn, laborious and acute, he visited the district three times, twice in the summer, and lastly in March, not without much fatigue and risk. His eager curiosity has placed him in a position to satisfy ours, and we reap tranquilly the fruit of his labours."[259] The reward Saussure offered for the first successful ascent of Mont Blanc served to broadcast his name and intentions, but it is also clear that his method and love of the mountains were a well-established fact.

Visiting Geneva a mere five years before Saussure's historic ascent, William Beckford, the architect of Fonthill, remarked upon the plethora of holidaymakers climbing the surrounding hills:

> The rage for natural history has so victoriously pervaded all ranks of people in the Republic that almost every day in the week sends forth some of its journeymen to ransack the neighbouring cliffs and transfix unhappy butterflies. Silversmiths and toymen, possessed by the spirit of Deluc's [sic] and Saussure's lucubrations, throw away the light implements of their

[259] Freshfield, 81.

> trade and sally forth with hammer and pickaxe to pound pebbles and knock at the door of every mountain for information. Instead of furbishing up teaspoon and sorting watchchains they talk of nothing but quartz and feldspath….I cannot help thinking so diffused a taste for fossils and petrifactions is of no very particular benefit to the artisans of Geneva, and that watches would go as well though their makers were less enlightened.[260]

Notwithstanding his apathy for the amateur science practiced by artisans, Beckford's harangue does much to elucidate the climate of the late-eighteenth century. That he recognized the role of de Luc and Saussure is perhaps unsurprising in late-century Geneva, but all the more valuable for the historian of these astute savants.

If the Alps represented an everyday fixture for the Swiss, "*les monts maudits*" symbolized a punishment for the perceived sins of the people. Faced with centuries of unchecked mythico-history and a cultural climate deeply ingrained in the European psyche, the task of transforming Europe's alpine mentality was a challenge for all who approached it. It is unlikely science alone could have risen to the challenge, for the developments of the eighteenth century, namely the desire for exotic travels, empire, and the intellectual progress of aesthetics functioned as a foundation for science. But with the requisite infrastructure in place, de Luc and Saussure challenged the scientific and cultural paradigm restraining alpine science and travel. And whether for leisure or science, it is clear that de Luc and Saussure influenced the cultural transformation of Switzerland, and ultimately, Europe.

Other than implementing their approach in the high Alps, neither de Luc nor Saussure can be credited as pioneers in scientific methodology - though their work in meteorology was truly innovative - but each functioned as an essential element of late-eighteenth century science. Yet history has ultimately been cruel to these two pioneers of

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[260] Ibid., 25.

alpine science. Especially with regard to de Luc, the history of science has yet to truly recognize his value, emphasizing his physicotheology and conveniently ignoring his attacks on mechanism and his innovative epistemological hierarchy. As Rudwick states, there is no mystery why this is: de Luc's explicit advocation of a geotheory riddled with Christian cosmology publicly clashed with his deist colleagues.[261] Saussure has been more fortunate, yet most have downplayed the ramifications of his pioneering work. The genuine respect proffered by so many of de Luc and Saussure's colleagues, many of whom history has immortalized, leads the historian of eighteenth century science to question the harsh treatment these individuals have received. In the sole biography of Saussure, Douglas Freshfield adamantly pleads his protagonist's case, emphasizing that alpine travel, science and aesthetics, as well as geology and meteorology are all indebted to Saussure for their emergence in the late-eighteenth century.[262] Instead, history typically recognizes Saussure only as the conqueror of Mont Blanc, crediting Alexander von Humboldt with the proliferation of global interconnection, quantification and alpine aesthetics.

The economic and imperial motives of the eighteenth century clearly encouraged exotic and colonial travel, but the heart of continental Europe remained an enigma until de Luc and Saussure illuminated its treasures with their rigorous methodology. Through planned fieldwork, instrumentation and precision measurement, knowledge previously local in character and subtly concealed by nature gained mobility. For the first time, the large, immovable masses of the Alps were decontextualized and disseminated throughout Europe by prose and visual proxy. With standardization providing equivalency, greater

[261] Rudwick, *Bursting the Limits of Time*, 151.
[262] Freshfield, 2.

numbers of natural philosophers could venture off the beaten path and still proffer comparable data that contributed to scientific progress and a concomitant increase in alpine travel. Moreover, as instruments and observation made sense of the chaotic mountains, their "otherness" decreased proportionately to their institutionalization.[263] Integrated into science and popular culture, the Alps gained prominence through the Romantic period and the subsequent era of nineteenth century mountaineering.

Ultimately, this dissertation has sought to elucidate two facets of history long bereft of meaningful analysis: the science and methodology of Jean-André de Luc and Horace-Benedict de Saussure, and the opening of the high Alps to science and culture. Though their work demonstrates a clear connection with that carried out by the quintessential natural philosopher Alexander von Humboldt, neither has received the detailed examination and recognition they deserve. Moreover, too few appreciate those brave individuals who, physically and intellectually, ventured off the beaten path to transform the perception of Europe's "Playground."

[263] Noah Heringman, "The Rock Record and Romantic Narratives of the Earth," 63.

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