

## “No former travellers having attained such a height on the earth’s surface”: Instruments, inscriptions, and bodies in the Himalaya, 1800-1830

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### Abstract

East India Company surveyors began gaining access to the high Himalaya in the 1810s, at a time when the mountains were taking on increasing political significance as the northern borderlands of British India. Though never as idiosyncratic as surveyors insisted, these were spaces in which instruments, fieldbook inscriptions, and bodies were all highly prone to failure. The ways surveyors managed these failures (both rhetorically and in practice) demonstrate the social performances required to establish credible knowledge in a world in which the senses were scrambled. The resulting tensions reveal an ongoing disconnect in understanding between those displaced not only from London, but also from Calcutta, something insufficiently emphasized in previous histories of colonial science. By focusing on the early nineteenth century, often overlooked in favor of the later period, this article shows the extent to which the scientific, imaginative, and political constitution of the Himalaya was haphazard and contested.

### Keywords

Himalaya; India; colonial science; surveying; instruments; bodies; senses; notebooks; borderlands

### Introduction

In high mountain spaces, the senses are scrambled and scale is elusive. In October 1818, Scottish brothers Alexander (1792-1839) and James Gilbert Gerard (1793–1835) found themselves high in the Himalaya after a sleepless and freezing night on the upper slopes of Reo Purgyl. Almost overcome by fatigue and altitude sickness, the brothers – both surveyors attached to the Bengal Infantry, Alexander as an officer and James as a surgeon – persevered upwards as, ‘we wished much to see the barometer below fifteen inches.’<sup>1</sup> Pursuing this scientific novelty was not a popular

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<sup>1</sup> Alexander Gerard, *Account of Koonawur, in the Himalaya*, ed. George Lloyd (London, 1841), 290. Reo Purgyl is located in what is now Himachal Pradesh, and is variously also known as Purgeool, Parkyul, Riwo Phargyul, Leo

proposition among the Tartar guides and porters the brothers were dependent on, and Alexander recorded that ‘we had infinite trouble in getting them to go on.’<sup>2</sup> His complaint was followed by a rather frank admission that: ‘to tell the truth, however, we could not have walked much faster ourselves, for we felt a fulness [sic] in the head, and experienced a general debility ... together with headaches and pains in the ears and breast.’<sup>3</sup> The constant and disturbing symptoms of altitude sickness, which James Gerard likened as ‘similar to the sedative effect of intoxication,’ included near-constant headaches, difficulty of breathing, insomnia, loss of appetite, weakness, lethargy, and hypoxia.<sup>4</sup> These bodily debilitations haunted the Gerards efforts at precise measurement, and were especially problematic given that they could not necessarily trust their senses in the high mountains where scale and distance are extremely difficult to judge. In his journal, Alexander continued, ‘it was 4 p.m. when we gained the summit, so we had no time to make half the observations we wished.’<sup>5</sup> This was exacerbated because their ‘hands were so numbed, that it was not until we had rubbed them for some time that we got the use of them.’<sup>6</sup> While Alexander fumbled with their theodolite, struggling to adjust it through bulky gloves, James had more success, getting readings from three homemade ‘mountain’ barometers, which all agreed at 14.675 inches. Even recording these precious measurements in the fieldbooks was far from trivial, as ‘the ink froze, and I had only a broken pencil, with which I could write very slowly,’ a significant limitation given how crucial notetaking was in a world that placed hypoxic stresses on the mind and memory.<sup>7</sup> Whatever the difficulties attached to precise, embodied and instrumentalized measurement in a world in which the senses were assaulted and untrustworthy, the impetus to keep moving upwards was nevertheless pressing. Indeed, the Gerards’ ascent occurred at a key moment not just for the

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Pargial, Tarhigang or Turheegung. Near identical accounts of this ascent were published elsewhere as Alexander Gerard, ‘Journal of an Excursion through the Himalayah Mountains, from Shipke to the Frontiers of Chinese Tartary’, *Edinburgh Journal of Science* 1 (1824): 41-52; 215-225; Alexander Gerard, ‘Narrative of a Journey from Soobathoo to Shipke, in Chinese Tartary’, *Journal of the Asiatic Society of Bengal* 11, no. 1 (1842): 363–91.

<sup>2</sup> Gerard, *Account of Koonawur*, 291.

<sup>3</sup> *Ibid.*

<sup>4</sup> James Gilbert Gerard, ‘A Letter from the Late Mr J.G. Gerard’, in *Narrative of a Journey from Caunpoor to the Boorendo Pass, in the Himalaya Mountains*, ed. George Lloyd, vol. 1 (London, 1840), 326.

<sup>5</sup> Gerard, *Account of Koonawur*, 291–92.

<sup>6</sup> *Ibid.*, 292.

<sup>7</sup> *Ibid.*

science of measuring altitude, but also for the imaginative and political constitution of the Himalaya as the northern borderlands of British India.

In this article, I examine surveyors' instrumental practices in the Himalaya across the first three decades of the nineteenth century, situating them in a context of growing insecurity around the lack of information about the mountains to the north of the East India Company's territory. I do so by focusing especially on three types of instruments – mountain barometers, boiling-point thermometers, and fieldbooks – and on the social performances required to render the knowledge they produced of the high mountains credible. In particular, I focus on the moments in which limits were exceeded, and instruments were found to be inadequate, or broke down and were repaired. These are revealing of the importance instruments played in establishing scientific personas and authority in a world in which the senses were unreliable.<sup>8</sup> The centrality of instruments is evident in the way that, later and from the relative luxury of the lowlands, Alexander Gerard compiled an unpublished note titled 'Memoir of the Construction of a Map of Koonawur,' in which he reflected at length on the technical aspects of the measurements taken on Reo Purguil. Using the readings from the barometers (those from the theodolite were no good), he calculated that the high point he and his brother had reached was not less than 19,411 feet, and likely more than 19,500 feet above the level of the sea.<sup>9</sup> As he continued, 'I have discussed the elevation of this station at some length, because the subject is interesting, from the circumstance of no former travellers having attained such a height on the earth's surface.'<sup>10</sup>

In making this claim (shared with an archivally invisible and unknown number of Tartars), Alexander Gerard was thinking specifically of Prussian polymath Alexander von Humboldt (1769-1859), whose high point on

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<sup>8</sup> For the significance of these moments, see Simon Schaffer, 'Easily Cracked: Scientific Instruments in States of Disrepair', *Isis* 102, no. 4 (2011): 706–17. On other efforts to repair and modify instruments in India see Jane Insley, 'Making Mountains out of Molehills? George Everest and Henry Barrow 1830-39', *Indian Journal of History of Science* 30, no. 1 (1995): 47–55; Pratik Chakrabarti, *Western Science in Modern India: Metropolitan Methods, Colonial Practices* (Delhi: Permanent Black, 2004), 39.

<sup>9</sup> Alexander Gerard, 'Memoir of the Construction of a Map of Koonawur,' 1826, British Library [hereafter BL]/European Manuscripts [hereafter Mss Eur.] D137, f200. This minor peak was significantly below Reo Purguil's true summit (or summits, with twin peaks causing some confusion), which Alexander calculated geometrically to be 22,630 feet. This would not be reached until 1933.

<sup>10</sup> *Ibid.* Early balloonists had, of course, reached greater heights *above* the earth's surface.

Chimborazo during his famous ascent of 1802 made him the previous holder of this distinction.<sup>11</sup> By engaging with Humboldt, Gerard was seeking recognition for what was an essentially arbitrary record. Indeed, as Humboldt chided towards the mid-century, ‘these mountain ascents, beyond the line of perpetual snow, however they may engage the curiosity of the public, are of very little scientific utility.’<sup>12</sup> Though carefully couched in the language of measurement, high mountains were beginning to serve as venues for imperial competition, and the scientific value of climbing them was, from the outset, always somewhat dubious. Who could go the highest (and instrumentally verify it) was a question that was nevertheless beginning to play out on a global canvas, even as the lack of demonstrable scientific relevance meant this was a distinction continued to be regarded with a degree of – perhaps feigned – ambivalence.<sup>13</sup> Though centered on the Himalaya, this article thus addresses the way knowledge was produced in mountain environments more generally, and demonstrates the way surveyors were compelled to compare and contrast their experiences with expectations arising from accounts of the Alps and the Andes.<sup>14</sup> Indeed, the first half of the nineteenth century saw increasing recognition of the idea that mountain environments were commensurate, and that natural phenomena needed to be mapped in three dimensions. In this sense, the story of measuring altitude is also the story of a rising sense of global verticality.<sup>15</sup> Growing interest in altitude and science, in turn, saw increased scrutiny around methods of accurately determining elevation above sea level, and the Gerards’ claiming of a new high point represents a key moment. In Alexander Gerard’s extended discussion of his instrumental practices, we will see

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<sup>11</sup> Neither Humboldt’s nor the Gerard brothers’ high points were ever actually the records they believed they were. Indeed, we now know (although the Gerards and Humboldt did not) from the archaeological evidence provided by the frozen bodies of the so-called ‘ice maidens,’ that Incas had reached the summit of Lulllaillaco in the Andes several centuries before the Gerards ventured into the Himalaya, an altitude that was significantly higher at 22,110 feet. Chinese travelers had almost certainly been higher as well. See Walt Unsworth, *Hold the Heights: The Foundations of Mountaineering* (London: Hodder & Stoughton, 1993), 191.

<sup>12</sup> Alexander von Humboldt, *Views of Nature: Or Contemplations on the Sublime Phenomena of Creation*, trans. E.C. Otté and H.G. Bohn (London, 1850), Vol 1, 236.

<sup>13</sup> The Gerards’ height ‘record’ would not be demonstrably broken again until 1855 by the Schlagintweit brothers. For this and the continuing reflexivity towards Humboldt in the Himalaya, see Gabriel Finkelstein, ‘Conquerors of the Künlün? The Schlagintweit Mission to High Asia, 1854–57’, *History of Science* 38, no. 2 (2000): 179–218.

<sup>14</sup> See for example John Hodgson’s discussion of refraction in James Herbert and John Hodgson, ‘Description of Passes in the Himalaya’, *Asiatic Journal* 9 (1820): 590.

<sup>15</sup> For a related take on verticality, see Reidy Michael S. Reidy, ‘From the Oceans to the Mountains: Spatial Science in an Age of Empire’, in *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, ed. Jeremy Vetter (New Brunswick: Rutgers University Press, 2011), 17–38.

that, in effect, the brothers had to ascend to their record-breaking height on Reo Purguil in two different ways – first physically with their instruments, and later socially in their descriptions and defence of their methods.

Questions around credibility were unavoidable in the high mountains, as devices originally conceived in Europe usually needed to be reconfigured – often in ad hoc ways – before they could be useful in spaces that placed immense stress on both bodies and instruments. Reconfigurations might be physical and reflect the terrain, enabling instruments to survive the rigors of mountain travel and labor conditions, or make them easier to operate in the face of bodily debility. However, these reconfigurations were just as often conceptual, and were linked to the way that, as Peter Bishop argues, ‘as yet, in the first half of the nineteenth century, the “frontier,” lacked imaginative coherence.’<sup>16</sup> This stemmed, in part, from uncertainties around the true scale of the mountains and the need to measure what were at the beginning of the nineteenth century unprecedented and unimaginable heights. The striving to address the imaginative, scientific, and political incoherence of the Himalaya (at least among European observers) over the first decades of the nineteenth century is reflected, as I will show, in the social performances surveyors employed to overcome the often simultaneous failures of instruments, inscriptions, and bodies. By focusing on the moments when the limits – of bodies, of technologies and of imperial mastery – are exceeded, often simultaneously, we can most clearly see the social practices and positioning upon which they rely. Throughout this article, the senses are considered as the interface between the body and the (often hostile) environment. Instruments could extend the senses, mediated by the inscriptions necessary to record them, but this was an unstable complex. Instruments, inscriptions, and bodies, when functioning together, had the potential to bring about coherence in the mountains, but because they were all prone to failure, the accumulation of this coherence was haphazard and contested.<sup>17</sup>

In all instrumental truth claims – as Simon Schaffer, Steven Shapin and others have shown – credibility depended on the status of the observers as much as the instruments.<sup>18</sup> In this article, I focus on the practices of a

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<sup>16</sup> Peter Bishop, *The Myth of Shangri-La: Tibet, Travel Writing, and the Western Creation of Sacred Landscape* (Berkeley: University of California Press, 1989), 89.

<sup>17</sup> This is in many ways a Latourian story of ‘cycles of accumulation,’ but one in which the distance acts on the center. See Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987), 223–28.

<sup>18</sup> Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985).

group of largely overlooked actors, represented alongside the Gerard brothers by John Anthony Hodgson (1777-1848), James Dowling Herbert (1791-1833), and William Spencer Webb (1784-1865). These individuals were all members of the Bengal infantry – employed as army officers and surgeons – but seconded to surveys in the Himalaya, and combined many of the characteristics of professional technicians with amateur scientific interests, albeit with variable success. While these surveyors sometimes traveled alongside the army, they usually operated autonomously within the tracts they had been assigned to survey. For the most part limited to traverse rather than trigonometrical surveys, their activities were not part of the Great Trigonometrical Survey proper, and the early Himalayan surveys were not subsumed into this project until closer to the middle of the century. Here Matthew Edney has demonstrated the ‘epistemological confusion which characterized the relationship of the Great Trigonometrical Survey with the Company’s other mapmaking activities,’ even if they shared the same political and economic imperatives for constituting frontiers and minutely mapping imperial domains.<sup>19</sup> Rather than gentlemanly scientific travelers (several of whom nevertheless have cameos in the story that follows), the Bengal infantry surveyors better fit the model of those grafting scientific proclivities onto institutional duties. In this sense, their activities were in many ways analogous to those performed by some contemporary naval officers and surgeons.<sup>20</sup> The surveyors left considerable and detailed records of their activities in correspondences (mostly official), fieldbooks, and maps preserved under the auspices of the Survey of India, and in published articles, especially those placed in fledgling Calcutta-based scientific journals. For these men, however oriented to Europe, their lives and careers nevertheless largely played out in India, in the mountains themselves, and in intellectual circles in Calcutta. Insufficiently emphasized in the scholarship on colonial science in India, this is central to understanding the way they dealt with the instrumental challenges in the Himalaya in both practice and print.<sup>21</sup>

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<sup>19</sup> Matthew Edney, *Mapping an Empire: The Geographical Construction of British India, 1765-1843* (Chicago: University of Chicago Press, 1997), 116–18. On revenue and traverse surveys see D. Graham Burnett, *Masters of All They Surveyed: Exploration, Geography, and a British El Dorado* (Chicago: University of Chicago Press, 2000); David Arnold, *Science, Technology and Medicine in Colonial India* (Cambridge: Cambridge University Press, 2004), 22–29.

<sup>20</sup> See for example Megan Barford, ‘D.176: Sextants, Numbers, and the Hydrographic Office of the Admiralty’, *History of Science*, 5 July 2017, doi:10.1177/0073275317712817.

<sup>21</sup> See for example Arnold, *Science, Technology and Medicine in Colonial India*, esp. Chapter 2. which focuses on EIC employees who leveraged scientific exploits in India into metropolitan careers.

While the physiological and psychological trials surveyors faced in the high mountains were real, they nevertheless needed to emphasize bodily hardship and sensory deprivation, and even exaggerate the idiosyncrasy of their surroundings, in order to leverage their ability to surmount these challenges. The surveyors worked to establish their credibility by showing instances when scientific and instrumental practices could not be transferred unmodified from those developed for the lowlands and hope to be effective. Accounts of instrumental practice in the Himalaya are intertwined with descriptions of, and an insistence on, challenges that could only be solved by those with direct experience of high mountain spaces. The use and reconfiguration of mountain instruments required an insistence on distance from metropolitan centers, reflecting not only a disconnect between the realities of scientific practice as understood between Europe and India, but also between Calcutta and the high spaces of the Himalaya.<sup>22</sup> Indeed, this article explores the ways scientific practice in the Himalaya – with its combination of challenges including assaults on the senses, logistics of portage, border politics, and ongoing inadequacies in instrument design – was construed as not only displaced from London, but also from India's 'centres in the periphery' like Calcutta, Madras, Benares, and Bombay.<sup>23</sup>

While conditions experienced in the Himalaya might have been less idiosyncratic than surveyors often insisted that they were, extreme mountain environments nevertheless tested the relationships between instruments, inscriptions, bodies, and authority.<sup>24</sup> Underlying this was the problem of un-instrumentally mediated senses in high places. As John Hodgson, one of the most prominent of the Bengal Infantry surveyors (and later Surveyor General of India) mused, 'whether it be from the changes in the atmosphere on high mountains, or the inconvenience of being

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<sup>22</sup> For the concept of 'double displacement' see Thomas Trautmann, 'Foreword', in *The Origins of Himalayan Studies: Brian Houghton Hodgson in Nepal and Darjeeling*, ed. David Waterhouse (London: Routledge Curzon, 2004), xviii. For the disconnect around instruments between London and Indian centers, in this case Bombay, see Simon Schaffer, 'The Bombay Case: Astronomers, Instrument Makers and the East India Company', *Journal for the History of Astronomy* 43, no. 2 (2012): 151–80.

<sup>23</sup> See Chakrabarti, *Western Science in Modern India*, 48–94.

<sup>24</sup> For the problems of estimating scale in mountainous spaces, and the possibility of calibrating one's senses with practice, see Marie-Noëlle 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*, ed. Marie-Noëlle Bourguet, Christian Licoppe, and H. Otto Sibum (London: Routledge, 2002), 96–125. See also Denis E. Cosgrove and Veronica Della Dora, *High Places: Cultural Geographies of Mountains, Ice and Science* (London: I.B. Tauris, 2009), esp. 9–12.

exposed to severe cold & high winds, I find my observations never agree a fourth part so well as on the plains.’<sup>25</sup> The ability to see greater distances and a lack of referents like trees or buildings meant that scale and proportion were extremely difficult to judge and ‘every one knows the extreme vagueness and liability to error in judging of the heights and distances of mountains merely by the eye.’<sup>26</sup> Nor were European senses the only ones on trial, as Alexander Gerard shows in his description of the Shatul Pass:

It is reckoned by the people of the country far more lofty than Boorendo; but the difference of elevation is only 450 feet ... it is not surprising that a few hundred feet should create a belief of a much greater altitude, since their ideas are formed upon local circumstances, such as the distance of the ascent, absence of trees, and quantity of snow, added to the difference of level from which they set out.<sup>27</sup>

Impaired judgment applied not only to sight, but also hearing as, ‘the diminution of the intensity of sound in a rarefied atmosphere is a familiar phenomenon to those who are accustomed to ascend very high mountains.’<sup>28</sup> In the high Himalaya, the senses could not necessarily be relied upon to provide a trustworthy interface with the environment, and the social performances required to establish credible knowledge were complicated accordingly.

Recently, there has been something of a resurgence of scholarly interest in the instruments of science and in instrumental practice. Within this, maritime and astronomical instruments have received the most attention.<sup>29</sup> Studies of maritime instruments in particular have interesting parallels with this story of mountain instruments, with marine barometers prone to breaking and ongoing tensions around ship’s officers owning their own instruments. However, in this article I shift the focus away from ships and observatories and into the spaces of the high Himalaya, to examine the spectrum of relationships between instruments, inscriptions, and bodies in a different sort of challenging environment. By doing so, we can gain a fuller understanding of the rhetorical strategies required to establish credible knowledge of remote locations which strained the limits of both bodies and technologies. This

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<sup>25</sup> John Hodgson, ‘Field Book of April 1816,’ National Archives of India [hereafter NAI]/Survey of India Records [hereafter SOI]/Fieldbook [hereafter Fdbk.] 87, f73.

<sup>26</sup> James Baillie Fraser, *Journal of a Tour through Part of the Snowy Range of the Himālā Mountains, and to the Sources of the Rivers Jumna and Ganges* (London, 1820), 329.

<sup>27</sup> William Lloyd and Alexander Gerard, *Narrative of a Journey from Caunpoor to the Boorendo Pass, in the Himalaya Mountains* (London, 1840), Vol 2, 286.

<sup>28</sup> ‘Miscellaneous Notices’, *Gleanings in Science* 1 (1829): 374.

<sup>29</sup> See Fraser MacDonald and Charles W. J. Withers, eds., *Geography, Technology and Instruments of Exploration* (Farnham: Ashgate, 2015), 4–5. See also special issues of *Osiris* (Volume 9, 1994) and *Isis* (Volume 102, No. 4, 2011).

follows from the way that, as Charles Withers has shown, ‘concerns over method and conduct’ in developing instrumental practices on a global scale were tied to tensions over the status of the field as a site of observation, such that ‘inscription and regularity of performance was both a scientific and a moral necessity.’<sup>30</sup> Beyond their practical applications, scholars have shown how instruments served multiple rhetorical functions in the accounts of European explorers, as justifications for their travels and as guarantors of their scientific credibility. As Nigel Leask suggests, instruments ‘represented talismans of authorial veracity,’ and separated scientific travelers from tourists.<sup>31</sup> This was nevertheless a complex relationship, and Dorinda Outram has pointed to the way that measuring with instruments did not automatically confer objectivity or universality in the first half nineteenth century, and ‘even if he used instruments to extend and calibrate sense impressions, what the explorer himself saw was crucial to establishing the truth-status of his observations’ and thus ‘instruments were thought of as enhancing human sense impressions rather than replacing them.’<sup>32</sup> In a similar vein, John Tresch argues for the social relationship between bodies and tools, and just as bodies could become instruments, so too instruments could become extensions of the body. Even further, ‘they not only extended his senses ... they were embodiments of his relations with others and his place in the natural and social world.’<sup>33</sup> As this article demonstrates, however, embodied instrumental practice in the Himalaya needs to be looked at through the lens of the limits of the senses as much as the disciplining or extension of them. Here the human and nonhuman elements are analyzed together, because to do otherwise would be to ‘reassert an artificial dualism of things and actions’ and as such ‘the distinction between corporeal and material, machine-like, devices is not relevant.’<sup>34</sup> Instruments could be metal and glass, or flesh and blood, and inscriptions might carry the traces of both bodily debility and congealed ink. Bruno Latour suggests that ‘objects, by the very nature of their connections

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<sup>30</sup> Charles W. J. Withers, ‘Science, Scientific Instruments and Questions of Method in Nineteenth-Century British Geography’, *Transactions of the Institute of British Geographers* 38, no. 1 (2013): 168; 174.

<sup>31</sup> Nigel Leask, *Curiosity and the Aesthetics of Travel Writing, 1770-1840: From an Antique Land* (Oxford: Oxford University Press, 2002), 73.

<sup>32</sup> Dorinda Outram, ‘On Being Perseus: New Knowledge, Dislocation, and Enlightenment Exploration’, in *Geography and Enlightenment*, ed. David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999), 283–89.

<sup>33</sup> John Tresch, ‘Even the Tools Will Be Free: Humboldt’s Romantic Technologies’, in *The Heavens on Earth: Observatories and Astronomy in Nineteenth Century Science and Culture*, ed. David Aubin, Charlotte Bigg, and Otto Sibum (Durham: Duke University Press, 2010), 270.

<sup>34</sup> Bourguet, ‘Landscape with Numbers’, 7.

with humans, quickly shift from being mediators to being intermediaries,' but in the high mountains, where the senses were scrambled, this process was neither quick nor linear.<sup>35</sup>

Despite the sensory derangement that came with the territory at high altitude, the human body itself might on occasion still directly become an instrument – if a potentially highly unreliable one – and Alexander Gerard thought it 'worthy of remark, that the Koonawurees and Tartars estimate the altitudes of the passes, by the difficulty of breathing they experience in ascending them.'<sup>36</sup> Just as Humboldt's body had become an altimeter during his ascent of Chimborazo, so too was this property of body-as-instrument ascribed to the local inhabitants of Kinnaur.<sup>37</sup> Such impressions could hardly be trusted, however, as Scottish geologist and botanist Hugh Falconer (1808-65) demonstrated, when he 'found the elevation to be 15,822 feet' which was 'considerably less than I imagined, as many of our party were attacked with the symptoms of distress about the head which extreme altitude brings on.'<sup>38</sup> In coming up against the limits of their senses, the surveyors might be seen as participating in what Charlotte Bigg describes as the 'on-going philosophical preoccupation with the role of sensory evidence in the constitution of knowledge' characteristic of this period.<sup>39</sup> Experiences of sensory derangement were of heightened interest in the early nineteenth century, especially through the viewing of panoramas, which might induce dizziness and 'seasickness,' as well as sublime reflections on mortality. Rather than something to be avoided, these sensory challenges were sought out, and in pursuing 'embodied modes of spectating' mountains and mountain views were prominent themes.<sup>40</sup> Though describing simulated rather than real danger, this literature is nevertheless helpful in

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<sup>35</sup> Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005), 79.

<sup>36</sup> Gerard, *Account of Koonawur*, 57. For more on instrumentalized bodies see Marie-Noëlle Bourguet, Christian Licoppe, and H. Otto Sibum, *Instruments, Travel and Science: Itineraries of Precision from the Seventeenth to the Twentieth Century* (London: Routledge, 2002).

<sup>37</sup> David N. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge* (Chicago: University of Chicago Press, 2003), 75.

<sup>38</sup> Hugh Falconer to [Thomas] Currie, 18 April 1839, BL/India Office Records [hereafter IOR]/F/4/1828 no. 75444, para 17.

<sup>39</sup> Charlotte Bigg, 'The Panorama, or La Nature À Coup D'oeil', in *Observing Nature - Representing Experience: The Osmotic Dynamics of Romanticism 1800-1850*, ed. Erna Fiorentini (Berlin: Reimer, 2007), 76.

<sup>40</sup> Alison Griffiths, *Shivers down Your Spine: Cinema, Museums, and the Immersive View* (Columbia University Press, 2008), 3. See also Stephan Oettermann, *The Panorama: History of a Mass Medium*, trans. Deborah Lucas Schneider (New York: Zone Books, 1997).

conceptualising the way Himalayan surveyors responded to sensory derangement in a world in which their bodily reactions could be unreliable and imprecise. Instruments and inscriptions had the potential to serve as anchors in an environment known for playing tricks on the eyes and placing hypoxic stresses on the mind, but this potential was limited when they too were often strained to the point of failure.

As much as from scientific interests, the impetus to take the instruments of science higher and higher into the Himalaya stemmed from increasing insecurity around the lack of information about the Company's northern borderlands, coupled with a realisation of the relative permeability rather than impenetrability of the range. Despite the efforts of Jesuit travelers, and the trade missions of George Bogle and Samuel Turner to Tibet in the late eighteenth century, European knowledge of the Himalaya in 1800 remained sparse and fragmentary, even as the mountains increasingly took on the role of a threatening 'blank space' at the edges of the empire that required filling in.<sup>41</sup> First on the subcontinent, and by the 1820s in Europe, it was finally becoming accepted that the Himalaya represented the highest reaches of the vertical globe, far higher even than the Andes and Humboldt's Chimborazo. However, the uncertainty – and briefly, outrage – around this revelation demonstrates the extent of the confusion and ignorance among British administrators when it came to the mountains at the north of their burgeoning Indian empire. Part of the delay in establishing the altitudinal supremacy of the Himalaya was that, due to the political situation along the mountainous frontier, measurements had mostly only been able to be taken from afar rather than *in situ*. This dynamic was altered by the Anglo-Gurkha War (1814-16), as at its conclusion the British acquired the provinces of Kumaon and Garhwal, opening up a much greater altitudinal cross-section of the Himalaya than had been easily accessible for several decades.<sup>42</sup> (The summits remained largely beyond reach, and as John Hodgson suggested, 'it is hardly to be expected that the higher peaks can ever be ascended to be determined barometrically.'<sup>43</sup>) The Bengal infantrymen were clearly aware of the potential military implications of their journeys, all having having served within the 'enormous dells and craggy heights' while personally involved in the hostilities with Nepal, and had

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<sup>41</sup> For a useful recent conceptualization of 'blank space,' see Dane Kennedy, *The Last Blank Spaces: Exploring Africa and Australia* (Cambridge, MA: Harvard University Press, 2013).

<sup>42</sup> See David Arnold, *The Tropics and the Traveling Gaze: India, Landscape, and Science, 1800-1856* (Seattle: University of Washington Press, 2006), 99–100.

<sup>43</sup> John Hodgson, 'Field Book of April 1816,' NAI/SOI/Fdbk. 87, f70.

experienced first-hand the porosity of the 'frontier which was penetrated at different points by the invading columns.'<sup>44</sup> They made efforts to note points of strategic interest, and this knowledge was later employed for military purposes, as seen in the way Alexander Gerard's map of Afghanistan (protracted from data gathered by James during a journey with Alexander Burnes in 1832-3) was used by the British army during their (ultimately disastrous) campaigns during the first Anglo-Afghan War of 1839-1842.<sup>45</sup> British access nevertheless remained far from complete, the challenges of terrain and topography notwithstanding, because of the continued autonomy of powerful rulers and states, including Ranjit Singh in the Punjab and ongoing resistance by the Kingdom of Nepal.

As well as checks by native political entities, increasing imperial ambition brought attendant concerns about Chinese and Russian activities to the north and northwest of the Himalaya respectively. Instead of presenting a reassuring and solid barrier, ignorance of the mountains increasingly bred insecurity. William Webb, for example, was rather put out to learn in 1816 that a friend had obtained from St Petersburg a publication describing his having crossed the Himalaya, 'regardées comme inaccessibles' but 'par lesquelles on peut ouvrir une route par la Tartarie jusqu'en Russie.'<sup>46</sup> Here the idea of insecurity is intended to signal a relative lack of knowledge and the threatening nature of this lacunae, something that evolved and fluctuated, but never went away over the course of the nineteenth century.<sup>47</sup> The challenge presented by 'blank space' and the insecurity this generated was essential not just in clearing away indigenous presences in preparation for European aesthetic and scientific appropriation, but also in propelling surveying, exploration, and the development of instrumental practice. Deploying instruments in the mountains was a political act in and of itself, and surveyors had to be particularly wary about using their instruments near the frontiers,

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<sup>44</sup> Lloyd and Gerard, *Narrative of a Journey*, Vol 1, 110.

<sup>45</sup> *Ibid.*, Vol 1, 283-6.

<sup>46</sup> Webb to Colin Mackenzie, 2 December 1817, NAI/SOI/Dehra Dun Volume [hereafter DDn.] 150, f27. ['regarded as inaccessible' but 'by which a route can be opened through Tartary to Russia']

<sup>47</sup> See Thomas Simpson, "'Clean out of the Map": Knowing and Doubting Space at India's High Imperial Frontiers', *History of Science* 55, no. 1 (2017): 3-36; Kyle Gardner, 'The Ready Materials for Another World: Frontier, Security, and the Hindustan-Tibet Road in the 19th Century Northwestern Himalaya', *Himalaya, the Journal of the Association for Nepal and Himalayan Studies* 33, no. 1 (2014): 71-84. For anxiety in British India more generally, see Jon Wilson, *The Domination of Strangers: Modern Governance in Eastern India, 1780-1835* (Basingstoke: Palgrave Macmillan, 2008).



Bengal infantry surveyors made multiple attempts to visit Tibet, though never to any avail, as Tartars with strict orders were always waiting to politely but firmly turn them around. As Alexander Gerard wrote: ‘I reached the limits of their country in four different quarters, but was not allowed to advance a step farther.’<sup>50</sup> These meetings were intricate acts of diplomacy, and Gerard described the Tartar *Lafa* he treated with as ‘inflexible in his determination’ though he ‘met me with an air of openness and good humour seldom equalled.’<sup>51</sup> All of Gerard’s attempts at negotiation were for naught, and neither letters of introduction nor the offer of substantial bribes were effective. The reality was that if he had decided to resort to violence, the Tartars would not have been able to stop him. He records the *Lafa* acknowledging this: ‘we will post ourselves on the road, but you have a sufficient number of people to force the passage, for we will not fight; we, however, trust you will not attempt it without permission.’<sup>52</sup> After William Moorcroft’s duplicitous and unsanctioned use of disguises to reach Lake Manasarovar in 1812 – which Gerard cited as a precedent for tensions – further diplomatic incidents were not something the East India Company was in a position to entertain, and the Bengal infantry surveyors were forced to check their instrumental ambitions at the Tibetan frontier.<sup>53</sup> At the same time they were struggling with the limits of bodies and instruments, the surveyors thus simultaneously found themselves coming up against the very real – if ill-defined – limits of empire and of British imperial mastery in the mountains.

In what follows, I examine tensions around the failures of bodies, instruments, and inscriptions in three sections, broadly thematic rather than chronological. In the first, I examine responses to damaged and destroyed instruments, focusing especially on moments in which instruments were found to be not functioning or inadequate, and how modifications and repairs might be effected or not in the mountains. This is followed by an examination of surveyors’ fieldbooks and inscriptive practices, which brings together the dual problems of the fragility of senses and the fragility of instruments in high mountain spaces. Finally, I consider the ongoing problems – both conceptual and physical – in instruments designed in Europe but intended for the highest mountains on the globe. I argue that the

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<sup>50</sup> Gerard, *Account of Koonawur*, 104–5.

<sup>51</sup> *Ibid.*, 104–6. *Lafa* was, according to Gerard, a generic term for chief.

<sup>52</sup> *Ibid.*, 104.

<sup>53</sup> *Ibid.*, 105; William Moorcroft, ‘A Journey to Lake Mánasaróvara in Ún-Dés, a Province of Little Tibet’, *Asiatic Researches* 12 (1816): 375–534.

staggered recognition of the true scale of the Himalaya reveals multiple levels of displacement in the understanding of scientific practices; that is, between actors in the mountains, in Calcutta, and in London. Throughout, I demonstrate the central role that social performances around the fragility of instruments, inscriptions and bodies – directed at both Calcutta and London – played in the Bengal infantry surveyors ability to establish their authority in a world of increasingly elevated scientific and political significance.

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When Alexander Gerard recorded that he had reached a new high point on the surface of the earth, he was well aware that this claim was not without the need for some pre-emptive defence. In a justification in which competitiveness and scientific utility blur, Gerard noted that:

As everything depends upon the accuracy of the instruments employed, I shall observe, that the barometers used by my brother and myself in 1818, which were the first successfully carried through this quarter of the hills, were manufactured by a native of India, and every precaution was taken to ensure precision.<sup>54</sup>

These instruments, made from tubes blown by a local craftsman and fitted up by the brothers with scales made from fir rods, had become necessary replacements when a set of mountain barometers they had ordered from London had been smashed in the process of being shipped from London. They were nevertheless excellent instruments, and when later compared, the Gerards' makeshift barometers were found in one case to differ 'only two feet from that deduced in the following year by Dollond's mountain barometer; and the discrepancies are rarely thirty feet.'<sup>55</sup> This remark points, however, to a key problem with the brothers' country-made barometers; specifically, a rhetorical one. The recognizable name of Dollond – one of the most respected of the London instrument makers – conveyed an authority that the Gerards' India-made devices never could. Indeed, Alexander Gerard felt compelled to return to the hypoxic and frightening heights in 1821 to confirm some of his earlier readings, this time with a pair of Dollonds acquired especially for the purpose, even while showing that they were not necessarily more accurate or precise.<sup>56</sup> There was a

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<sup>54</sup> Gerard, *Account of Koonawur*, 161.

<sup>55</sup> *Ibid.*, 164.

<sup>56</sup> James Gerard returned to the Reo Purguil high point itself in 1820, and made additional barometrical measurements. With the Dollonds in 1821, Alexander only took measurements of lower stations, but used the comparisons to argue for the accuracy of the homemade barometers used in 1818. Gerard, 'Memoir of the Construction of a Map of Koonawur', f200-1.

tension between instruments from the workshops of reputed metropolitan artisans that provided credibility but were ill-suited to the scale and challenging topography of the Himalaya, and India-made, modified, and repaired instruments that functioned well in mountainous spaces, but lacked rhetorical claims to authority.

Taking altitudes by barometer was becoming preferred by the 1820s, and the go-to solution when logistics or terrain prevented trigonometry, having the advantages of relative simplicity and reasonable accuracy.<sup>57</sup> Using mercury filled tubes to measure air pressure was a well-established practice, dating back to the seventeenth century, and barometers explicitly intended for measuring height – ‘mountain’ barometers – had been in use since the eighteenth century, with Horace-Bénédict de Saussure carrying one to the summit of Mont Blanc in 1787, William Kirkpatrick using them in Himalayan foothills of Nepal in 1793, and Humboldt deploying them on Chimborazo in 1802.<sup>58</sup> The biggest limitation of barometers, however, was that they were inherently fragile and easily damaged (or destroyed) by the rigors of travel. Rates of attrition were high, and as Alexander Gerard recorded: ‘two barometers were left at Soobathoo [as controls], and out of the fourteen which we took with us, only two returned in safety.’<sup>59</sup> Beyond their fates in the mountains, barometers were often broken during shipping from Europe, and arrived in India already unserviceable. John Hodgson lamented, for instance, that his new barometers had all arrived smashed to pieces and pleaded that, ‘whenever barometers are sent, there should be to each at least 6 spare tubes filled in England by the maker & these should be carefully packed in separate cases of copper or wood lined with flannel.’<sup>60</sup> Even those that made it to India intact could still be destroyed on their way from Calcutta to Himalayan staging

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<sup>57</sup> Despite increasing reliance on barometers, they did not as yet instill as much confidence in scientific audiences as altitudes determined geometrically. Alexander Gerard was aware of this, noting that the Reo Purgyl station ‘being a principal point, and I believe the greatest height ever attained on the earth’s surface, either in India or any other country, I was at some pains to determine it ... by trigonometry.’ Gerard, *Account of Koonawur*, 176. However, applying trigonometrical methods in the Himalaya had its own rhetorical issues around refraction, was arduous and resource intensive, and in many cases was simply unfeasible in the first decades of the nineteenth century. The continuing development of trigonometrical methods thus occurs in parallel with this story, even while I focus here on the social performances around barometers and thermometers that were necessary to establish them as instruments capable of measuring altitude with tolerable – or even comparable – accuracy.

<sup>58</sup> For eighteenth-century developments in measuring altitude using barometers, see Theodore S. Feldman, ‘Applied Mathematics and the Quantification of Experimental Physics: The Example of Barometric Hypsometry’, *Historical Studies in the Physical Sciences* 15, no. 2 (1985): 127–95; Bourguet, ‘Landscape with Numbers’.

<sup>59</sup> Gerard, *Account of Koonawur*, 162.

<sup>60</sup> John Hodgson, ‘Field Book of May 1817’, NAI/SOI/Fdbk. 91, f170. Makers of marine barometers faced similar problems, as the sloshing of the mercury in rough seas also tended to break tubes.

grounds like Saharanpur or Subathu. James Herbert, for example, recorded that a long-awaited barometer he had ‘looked forward to’ was damaged on the *dawk* journey from Calcutta, though by reboiling it he was able ‘to restore its value.’<sup>61</sup> No sooner had it been repaired, however, than it was smashed again, this time in a definitive fashion – ‘broken by the carelessness of the servant who had charge of it and rendered utterly useless’ – a loss ‘much to be regretted independent of its pecuniary value’ as it was irreplaceable so far from the workshops of London.<sup>62</sup> While at Saharanpur, Herbert was forced to attempt to manufacture an alternative, using ‘tubes which are constructed here by Native Glass men.’<sup>63</sup> In these instances, Indian instrument makers were usually reduced to rote laborers rather than artisans, with Europeans appropriating credit for providing the instruction, which was also essential to establishing the credibility of the final product.<sup>64</sup>

The fragility of barometers was partially addressed by developing methods for repairing and replacing tubes in the field. However, as Hodgson recorded in his fieldbook of May 1817 – while being rocked by earthquakes as he struggled to become the first European to reach the source of the Ganges – boiling tubes was a vexing endeavor and ‘none but a professed artist can expect to succeed in this difficult business, once in ten times.’<sup>65</sup> The difficulty of boiling tubes in the mountains was frustrating given this had the advantage of overcoming the lag-time of potentially more than a year when ordering instruments over from Europe (not to mention the ongoing problem of pre-filled tubes arriving already broken). In these moments though, the embodied observers might prove as fallible as the instruments, and Hodgson admitted to being ‘too much tired to attempt to boil the mercury in the tubes today,’ while the ‘frequency of the earthquakes made us very anxious to get out of our dangerous situation in the bed of the river.’<sup>66</sup> Hodgson made use of his imperfect barometer anyway, insisting that it was still of value and: ‘with the

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<sup>61</sup> Herbert to Charles Lushington, 7 February 1827, BL/IOR/F/4/1068 no. 29191, f31-2

<sup>62</sup> *Ibid.*, f32.

<sup>63</sup> *Ibid.*, f33.

<sup>64</sup> ‘Literary and Philosophical Intelligence’, *Asiatic Journal* 11 (1821): 377. Occasionally Indians might be considered artisans, the most prominent example being Mir Mohsin who worked as instrument maker in the Surveyor-General’s office for the better part of two decades. See Joydeep Sen, *Astronomy in India, 1784-1876* (London: Pickering & Chatto, 2014), 85–89.

<sup>65</sup> John Hodgson, ‘Field Book of May 1817’, NAI/SOI/Fdbk. 91, f169. A version of this account was also published as John Hodgson, ‘Journal of a Survey to the Heads of the Rivers, Ganges and Jumna’, *Asiatic Researches* 14 (1822): 60–152.

<sup>66</sup> John Hodgson, ‘Field Book of May 1817’, NAI/SOI/Fdbk. 91, f167; 171.

unboiled mercury there must be an error but I should not think it can affect the height more than 200 feet & generally not 100 feet & as under the present circumstances we cannot do more.<sup>67</sup> In examples like these, as Charles Withers, Innes Keighren, and Bill Bell argue, the fact that observers 'had *tried*, if not succeeded, was nevertheless central to their self-positioning as credible, scientifically minded observers.'<sup>68</sup> Even when boiled successfully, questions over whether a barometer was of the same value once it had been repaired or modified were unavoidable. French traveler and naturalist Victor Jacquemont (1801-32), after vilifying his Asian assistant for breaking one of his barometers, had it repaired but noted that 'Il n'était déjà plus comparable avec l'étalon de l'observatoire de Paris, puisque j'en avais changé le tube,' and subsequently never trusted the instrument the same way.<sup>69</sup> These moments are revealing, leading to what Simon Schaffer has called the importance of 'managing states of disrepair' in instrumental practice, something that was especially critical in far-flung, displaced locations like the high Himalaya, where replacements and expert repairs were not readily available.<sup>70</sup> In turn, managing disrepair required emphasizing the dangers and difficulties faced in order to justify the use of less than perfect instruments, and to establish the credibility of any claims made using them. The fieldbooks of the Bengal infantry surveyors are rife with descriptions of improvised and ad-hoc instruments, complete with almost desperate insistence by their observers that the readings they were producing were of value.

Given these difficulties, one possibility was to turn to a different class of instruments entirely. While barometers were deservedly popular, determining altitude by calculating the falling temperature of the boiling point of water had long been known – 'an experiment exhibited in every class where natural philosophy is taught' – as a reasonably accurate method of determining elevation above sea level.<sup>71</sup> The smaller boiling-point thermometers were somewhat less fragile than the larger barometer tubes, cheap, and relatively straightforward to use. On the other hand, the boiling-point method could never deliver as high a degree of accuracy, reliability or precision, and the

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<sup>67</sup> *Ibid.*, f169.

<sup>68</sup> Innes M Keighren, Charles W J Withers, and Bill Bell, eds., *Travels into Print: Exploration, Writing, and Publishing with John Murray, 1773-1859* (Chicago: University of Chicago Press, 2015), 97.

<sup>69</sup> Victor Jacquemont, *Voyage Dans l'Inde Pendant Les Années 1828 À 1832* (Paris: Firmin Didot frères, 1841), Vol 2, 156. ['it was no longer comparable with the standard of the Paris Observatory, since I had changed the tube']

<sup>70</sup> Schaffer, 'Easily Cracked', 709.

<sup>71</sup> Gerard, *Account of Koonawur*, 177.

necessity of having firewood on hand (and the ability to make a fire in an extreme environment) to boil the water could prevent its use. According to Alexander Gerard, John Hodgson was ‘the first person in India who thought this method sufficiently accurate for determining heights,’ and his opinion carried significant weight once, his constitution shattered from the brutal work of the survey, he moved from the mountains to Calcutta to take up the job of Surveyor General in 1821 and had the opportunity to apply his direct experience of the high places.<sup>72</sup> Indeed, the boiling-point method was enthusiastically advocated by Hodgson, who acknowledged that even if it was ‘only approximative’ this was to a ‘very desirable degree in many cases.’<sup>73</sup> (It also had, as English scientist and orientalist scholar James Prinsep (1799-1840) noted, the benefit of allowing one to simultaneously practice science and brew oneself a reinvigorating cup of tea.<sup>74</sup>) The boiling-point nevertheless largely remained a secondary method and a useful backup, such as when a parties’ barometers had all been broken or were with straggling porters and not to hand. Indeed, thermometers were only approximative instruments and even if they ‘very seldom indeed gave the altitude 300 feet different from the barometer,’ the rhetorical work required to establish their credibility exceeded that of barometers.<sup>75</sup>

In spaces where terrain and logistics frequently exposed the inherent fragility of the available apparatuses of science, self-sufficiency and the ability to repair instruments with rudimentary supplies, or find Indian craftsmen who could, was critical to the required skill set of the Bengal infantrymen. As a pseudonymous contributor to *Asiatic Journal* of 1818 wrote, if a young surveyor:

Received some instruction in this country that might enable him to replace a screw, or any similar defect, in an instrument, to replace the glass tube to a barometer, in filling a spare tube with quicksilver, it may become . . . of the greatest importance in a distant survey, for it would be in vain, then, to think of aid from the mathematical instrument-makers residing in Europe, or even of any that might, or might not happen to dwell in Calcutta.<sup>76</sup>

For those operating in locations displaced not only from London but also far removed from Calcutta, innovation and self-reliance were essential. Hodgson argued, admittedly from a position of pride as he stepped down from his second

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<sup>72</sup> Ibid. Hodgson was Surveyor General from 1821-23, and again from 1826-29.

<sup>73</sup> Herbert and Hodgson, ‘Description of Passes in the Himalaya’, 589.

<sup>74</sup> James Prinsep, ‘Table for Ascertaining the Heights of Mountains from the Boiling Point of Water’, *Journal of the Asiatic Society of Bengal* 2 (1833): 200.

<sup>75</sup> Gerard, *Account of Koonawur*, 307.

<sup>76</sup> [Amicus], ‘Remarks on the Himalaya Mountains’, *Asiatic Journal* 5 (1818): 323–24.

brief tenure as Surveyor General, that ‘the best geographers have not been issued from the learned universities and academies’<sup>77</sup> and instead:

are, and will be, the officers of the native army, Captains and subalterns, men accustomed to march from one extreme of this vast country of Hindoostan to the other; observers of localities and manners, and learning in the school of necessity & experience how to adapt means to ends.<sup>78</sup>

In the 1810s, members of the Government in Calcutta proposed employing professionals rather than seconded army officers for the Himalayan surveys, but Hodgson was dismissive because those specialist engineers ‘who possess sufficient local knowledge to make them useful as surveyors have more pleasant and profitable duties open to them,’ and suggested that ‘nothing but necessity or a strong bias towards the science ever made any man serve in the dangerous and arduous work of surveying.’<sup>79</sup>

Beyond the risks and physical hardships were significant expenses, especially those associated with the large parties that surveyors had to travel with to transport their instruments. Costs meant limitations, and Alexander Gerard, as a working surveyor rather than gentlemanly traveler, complained that he had an allowance of only 250 rupees a month ‘whilst the wages of the porters alone, for my baggage and instruments, (exclusive of my own Servants & expenses) amounted to upwards of 400 Rps per month, I had not the means of extending my journey longer.’<sup>80</sup> The instruments themselves also represented a financial burden, often purchased and owned by surveyors personally, with significant potential to be lost, stolen or broken in the mountains. William Webb wrote in 1815 that he had ‘no instrument, of any description, belonging to Government, and have, including barometers, expended nearly £1200 on instruments, a great proportion of which arrived (or have since been) broken.’<sup>81</sup> Though official instruments existed and ‘there were occasions when Government instruments were issued on loan or payment,’ the tools supplied by the government tended to be of inferior quality ‘sent by contractors trying to maximise their

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<sup>77</sup> Hodgson to Duncan Montgomerie, 30 November 1826, NAI/SOI/DDn. 220, f219.

<sup>78</sup> Hodgson to William Casement, 24 January 1829, NAI/SOI/DDn. 231, f262-3.

<sup>79</sup> Ibid., f260-1.

<sup>80</sup> Gerard, ‘Memoir of the Construction of a Map of Koonawur’, f206.

<sup>81</sup> Webb to Colin Mackenzie, 8 October 1818, NAI/SOI/DDn. 150, f69.

profits' and in some cases 'so bad & rough' as to be hardly worth the 'expence of carriage for them.'<sup>82</sup> James Prinsep remarked, for example, that 'on some standard thermometers in the Surveyor General's office ... we found the boiling point erroneous *two degrees*,' a margin of error that meant heights could be off by as much as 1000 feet.<sup>83</sup> The expenses for essential but inherently fragile instruments were partially reimbursed through the Company's unwieldy surveying allowances system, but this was rarely sufficient.<sup>84</sup> The protracted struggles of the Bengal infantrymen to make administrators in Calcutta and London understand the instrumental challenges they faced in the high mountains highlights the ongoing imaginative disconnect between those in the Himalaya and those below. These concerns also further show the tensions around the professional status of Himalayan surveyors as employees of the East India Company, and their amateur grafting of scientific interests onto official duties, pointing to the sometimes uneasy relationship between the Company state and the unofficial and idiosyncratic networks of scientific patronage that functioned within it. This tension was exacerbated by insecurity around the lack of information about the mountain borderlands, but for knowledge to make its way out of the mountains it first had to be written down, and this was far from straightforward in a world in which bodies, senses, instruments, and inscriptive practices were all pushed to their limits and beyond, as the next section will explore.

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In August 1822, James Gerard once again found himself high in the Himalaya, this time atop the Shatul Pass, which he calculated by barometer to be 15,500 feet above the sea. He had returned to the Shatul because he was hoping to recover some fieldbooks and instruments (a telescope and a thermometer) which had been lost during a prior expedition. In September 1820, they had vanished into the Himalayan snows after the boy carrying them and another

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<sup>82</sup> R.H. Phillimore, *Historical Records of the Survey of India* (Dehra Dun: Survey of India, 1954), Vol 3, 211-22; Hodgson to Colin Mackenzie, 1 July 1816, NAI/SOI/Memoir [Hereafter Mem.] 60, f273. For more on issues around inferior instruments being sent to India, see Schaffer, 'The Bombay Case'.

<sup>83</sup> Prinsep, 'Table for Ascertaining the Heights of Mountains', 198.

<sup>84</sup> See for example 'Captain Alexander Gerard Recommences His Survey of Malwa and Rajputana,' 1822-7, BL/IOR/F/4/1017 no. 27954.

porter had frozen to death at midday, the result of exposure and wind-chill during an unexpected blizzard.<sup>85</sup> Gerard described his search for the fieldbooks in a letter that was later published, writing that after first discovering the ‘bones and clothes of the Brahmin who carried a bundle of sticks’ he continued down until:

We came upon the body of the little boy who carried the field-book and all the papers of the route. He was half buried under the snow. He lies at 13,500 feet. We searched in vain for traces of the books, so that they are for ever lost. This being a chief object of my tour, and one I had much at heart, it made me look forward to the rest of it with less interest, but I had determined to ascertain the correct elevation of the cave, and continued descending.<sup>86</sup>

The freezing conditions had left the body preserved – ‘with all his clothing on, and his corpse untouched’ – a reminder, not that Gerard needed one, of the fragility of bodies in an extreme environment.<sup>87</sup> Gerard’s lament points to the way that fieldbooks, and the instrumental data they contained, could have especial, almost talismanic, significance to the surveyors, and the loss of information is represented as more poignant than the loss of life. Instruments, inscriptions, and bodies, which needed to work together to establish the credibility of claims about the high mountains, were all fragile and prone to failure in high places. The social performances required to overcome these were somewhat different for fieldbooks than they were for barometers, as this section will show, focusing on the moments when both writing materials and inscriptive practices broke down. Measurements using precision instruments were of little value if the data they produced could not be successfully transmitted out of the mountains, and the fieldbooks – fragile and idiosyncratic – were the sometimes shaky cornerstone of the relationship between bodies, senses, and instruments in the high Himalaya.

In 1818, and only shortly before becoming Surveyor General himself, John Hodgson was scolded by the Surveyor General’s Office in Calcutta for failing to lodge his fieldbooks in a timely manner. In response, he noted that all his fieldbooks were:

Digested and compiled from the rough notes taken as I proceed and written briefly in the open air and often in the rain and snow so as frequently to be hardly intelligible to any but the writer ... they are interspersed in various books with miscellaneous matter of tentative calculations, extracts and tables copied from scientific works ... almost illegible owing to the circumstances under which they were written.<sup>88</sup>

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<sup>85</sup> Gerard, *Account of Koonawur*, 93.

<sup>86</sup> Gerard, ‘A Letter from the Late Mr J.G. Gerard’, 313–14.

<sup>87</sup> *Ibid.*, 314. See also Ann C. Colley, *Victorians in the Mountains: Sinking the Sublime* (Farnham: Ashgate, 2010), 220.

<sup>88</sup> Hodgson to Charles Lushington, 12 December 1819, NAI/SOI/DDn. 145, f69-70.

Fieldbooks, being made of ephemeral materials like paper, card, and parchment, were by their nature vulnerable. As well as being effaced by snow and rain or in river crossings, they might be lost entirely, as in the case of James Gerard's fieldbooks on the Shatul, or Herbert who ruefully had to report that: 'the total distance to the [Gunas] pass I have no means now of ascertaining, for the last few leaves of the route-survey ... were afterwards blown from the book on the stormy summit of the pass.'<sup>89</sup> As much as a broken barometer might render a surveying expedition a waste of time, the inability to write or failure of writing materials might have the same effect. Indeed, like barometers and thermometers, fieldbooks would be developed as a technology of exploration, so that by 1854 the authors of 'Hints to Travellers' could recommend that: 'writing and drawing materials, stationery, scales, tapes, and register-books, should be carried in convenient cases – water-tight, if possible.'<sup>90</sup>

The inclusion of fieldbooks alongside other scientific instruments in this article follows recent interest in the practices of inscribing observations in the field, and the relationships between memory, writing and editing practices. Here Marie-Noëlle Bourguet has shown that 'the rationale for travel note-taking derived from the twin dangers of an unruly observation in the field and an unreliable memory.'<sup>91</sup> Bodily movement and inscription were intertwined, and good notetaking practice involved disciplined, daily writing coupled with an attention to intelligibility.<sup>92</sup> However, this was more often the ideal than the reality in the face of the extreme topography, and Herbert confessed that often while traveling in the mountains, 'the fatigue is so great that it is impossible after arriving at the ground to set down immediately, to copy field books, or protract.'<sup>93</sup> Bodily limitations meant that rough field jottings usually needed to be transcribed and edited before they were useful, and most calculations were not performed on the spot but worked up later. Notetaking discipline was also important in a more morbid sense, as fieldbooks could, assuming they were

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<sup>89</sup> Phillimore, *Historical Records of the Survey of India*, Vol 3, 42.

<sup>90</sup> Henry Raper and Robert FitzRoy, 'Hints to Travellers', *Journal of the Royal Geographical Society of London* 24 (1854): 329. See also Keighren, Withers, and Bell, *Travels into Print*, 43.

<sup>91</sup> Marie-Noëlle Bourguet, 'A Portable World: The Notebooks of European Travellers (Eighteenth to Nineteenth Centuries)', *Intellectual History Review* 20, no. 3 (2010): 381.

<sup>92</sup> See Charles W J Withers and Innes M Keighren, 'Travels into Print: Authoring, Editing and Narratives of Travel and Exploration, c.1815–c.1857', *Transactions of the Institute of British Geographers* 36, no. 4 (2011): 565.

<sup>93</sup> James Herbert, 'Field Book of August 1818', NAI/SOI/Fdbk. 97, f37. For a related discussion of fatigue and 'physiological traces' in the context of notetaking in the Alps, see Philipp Felsch, 'Mountains of Sublimity, Mountains of Fatigue: Towards a History of Speechlessness in the Alps', *Science in Context* 22, no. 3 (2009): 341–364.

intelligible, serve to transmit data in a manner that might transcend the unfortunate deaths of their makers. This is evident from a moment in which it went wrong. In 1842, having recovered several of James Herbert's fieldbooks following his untimely death, John Hallet Batten (1811-86) lamented that several were: 'badly written, and parts of them are very obscure. One of the vols. is written topsy-turvily, *i.e.* one set of observations are recorded on one side of a page, and another set on the other, and large *lacunae* intervene.'<sup>94</sup> As he continued though:

Luckily this volume relates to Kumaon, and British Gurhwal, tracts with which I am intimately acquainted, and my local knowledge enables me to decypher the names of places, and connect the threads of the narrative. I assure you that nobody at Calcutta can possibly interpret the volume in question.<sup>95</sup>

In these volumes, lack of discipline and good notetaking practice diminish the value of Herbert's books, and increase the difficulty of extracting useful knowledge. Batten's social performance nevertheless rests on explicitly claiming distance from those in Calcutta, and asserting that only someone with direct experience of the displaced spaces of the Himalaya might be able interpret the imperfectly inscribed notes (and if those in Calcutta would struggle, what hope for interpreters in London?). Here, as in other social performances by the Bengal infantrymen, it is a deliberate insistence of the idiosyncrasy of Himalayan spaces that elevates Batten's contribution to the increasingly pressing questions around the true scale of the Himalaya.

Reliable and immediate inscription, and disciplined notetaking practice, were especially critical in an environment that induced extreme fatigue and the stresses of altitude sickness, which might resemble intoxication. Against these sensory assaults, fieldbooks could be examined and held up as talismans of authority, and as bulwarks against later failings of memory, editorial meddling or hindsight rejigging. Indeed, fieldbooks might have noteworthy afterlives, such that transparency in method, recognition of potential sources of error, and the provision of the raw uncorrected measurements – 'for those persons who may wish to re-calculate them' – was an important consideration.<sup>96</sup> This was especially so given the status of the Bengal infantrymen as working surveyors rather than gentlemen, and the way they sometimes awkwardly combined the characteristics of amateur enthusiasts and

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<sup>94</sup> 'J.H. Batten to Henry Torrens, 8 February 1842', *Journal of the Asiatic Society of Bengal* 11, no. 1 (1842): 583.

<sup>95</sup> *Ibid.*

<sup>96</sup> Gerard, *Account of Koonawur*, 165.

professional technicians. The tension around the surveyors' status was very apparent when it came to the controversy surrounding the true height of the Himalaya, and their supremacy over the Andes. As Herbert wrote:

I would first observe, that this survey involves as a principal point the determination of the height of the Himmaleh now acknowledged to be the highest range of mountains in the world by all except such as at home think science confined to Europe & that it is impossible for an officer in the Company's service to measure the height of a mountain.<sup>97</sup>

Herbert continued that:

In the determination of this point I think I may say the national honor is concerned as well as that of the Bengal Army. To satisfy such prejudiced ... judges it is evident that something more is required than the more routine work which it is the lot of most surveyors to furnish ... no determination of heights will ever satisfy the curious in Europe that is not accompanied with ample details as to the original observations as well as a full exposition of the methods of calculation.<sup>98</sup>

The fieldbooks of raw data, alongside careful justifications of the instrumental practices developed and the conditions they were used under, become essential. Hodgson and Herbert went on to sum up their findings by placing an emphasis on their authority by distance and their ability to operate in a physiologically extreme and sense-scrambling world:

While we deprecate the theorists pronouncing too decidedly on the value of results, which may appear to him, much too discordant, we feel confident that in the eyes of the practised observer, who will consider the nature of our instruments, and the difficulties with which we had to contend, these very discrepancies will prove our strongest claim to his confidence.<sup>99</sup>

The making available of field-books was a rhetorical strategy for claiming credibility, even if this also implies that interpreting the data might rely on first-hand experience of particular places. Herbert and Hodgson are, like Batten, claiming distance from not just London but also Calcutta, and thereby establishing their privileged ability to produce knowledge of displaced spaces from within them. Their challenge to the 'theorists' is nevertheless muted because, in carefully laying out the particulars of their practices and instruments, it is ultimately the acceptance and approbation of these gentlemen that they are seeking.

Beyond the precious data they carried – the *raison d'être* of heading into such extreme environments at all – fieldbooks were also crucial to Himalayan surveyors (specifically those answering to the Bengal Presidency) in a more

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<sup>97</sup> Herbert to Colin Mackenzie, [nd] 1819, NAI/SOI/DDn. 152, f130.

<sup>98</sup> *Ibid.*, f130-1.

<sup>99</sup> John Hodgson and James Herbert, 'An Account of Trigonometrical and Astronomical Operations for Determining the Heights and Positions of the Principal Peaks of the Himalaya Mountains', *Asiatic Researches* 14 (1822): 211.

practical sense, in that they needed to be furnished to be reimbursed for surveying allowances. Regulations stated that fieldbooks had to be sent back monthly, though this was often an impossible ask in the mountains. Sometimes, Hodgson resorted to sending a summary: 'I call it a field book to entitle me to my allowance as I am in debt for the expenses of my extra hill carriage.'<sup>100</sup> Surveyors frequently complained at the impracticality of having copies made in the mountains, and the limited availability of trained scribes.<sup>101</sup> The problem was that the regulations were designed for the plains, and failed when they came to the mountains where labor and portage were more expensive, copyists scarcer, and repairing or obtaining replacement instruments a much slower process. In an extended critique of the fieldbook regulations, Hodgson cited as his most glaring example of this disconnect that:

by the regulations all surveys are to be discontinued during the rainy season, and the full allowance of a surveyor cease, but it is in that season alone, when the snow is to a certain degree melted, that we can best explore these deep recesses of the Himalaya, where the rivers originate.<sup>102</sup>

Fieldbook regulations were unpopular and were ongoing sources of friction between those in the mountains and those in Calcutta, further highlighting the disconnect in the understanding of the conditions and bodily hardships associated with scientific practice in the high mountains. By the time Hodgson descended from the mountains to take up the post of Surveyor General in 1821 and had the opportunity to apply his direct experience to redressing the regulations, the problem was urgent. As William Webb argued, 'no person would undertake the fatigues, risks, and exposure of those alpine journies, with the chance of being fined in the amount of his establishment.'<sup>103</sup>

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Beyond developing practices for day-to-day repairs, intelligible inscription and the repurposing of inadequate devices, it was quickly apparent to the Bengal infantry surveyors gaining access to the high Himalaya in the 1810s that the instruments offered by London artisans had notable limitations, both conceptual and physical. Central to this was the need for instruments that would read low enough to give altitudes for the highest elevations such instruments had

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<sup>100</sup> John Hodgson, 'Field Book for September & October 1816', NAI/SOI/Fdbk. 91, f7.

<sup>101</sup> Hodgson to William Casement, 6 November 1827, NAI/SOI/DDn. 231, f77.

<sup>102</sup> Hodgson to Lieut. Colonel Young, 12 July 1818, NAI/SOI/DDn. 152, f66-7.

<sup>103</sup> William Webb to Colin Mackenzie, 8 October 1818, NAI/SOI/DDn. 150, f71.

ever been deployed at.<sup>104</sup> Indeed, Alexander Gerard wrote of standard barometers – even those marketed as ‘mountain’ barometers – with exasperation as ‘all I have seen are not adapted for the measurement of very high places.’<sup>105</sup> He continued that while one ‘went as low as 20 inches’ it would nevertheless ‘be of no use amongst the Himalaya, where I have travelled many hundred miles without having the barometer above 19½ inches, and once so low as 14.675 at the height of 19,450 feet.’<sup>106</sup> Gerard leverages his authority from experience, elevating himself from a mere data gatherer to a scientific pioneer. As a contributor to the Calcutta-based journal *Gleanings in Science* reveals, scales were an ongoing problem even in 1829: ‘when I ordered my brass scales from Dollond, I had them divided down to 17 inches, which I imagined, then, would be the limit of their travels upward.’<sup>107</sup> However, ‘the mercury sunk 1 1/2 inch below this point’ and the observer was forced to try and compensate for this by carving marks below the scale with a penknife in the hope of extending it later.<sup>108</sup> In this instance, the instrument’s unsuitability for the task was literally inscribed into it. There was an ongoing disconnect between instruments designed in Europe (perhaps for the Alps) and those needed for the highest mountains on the globe. That instruments capable of measuring very high places remained hard to come by even in the 1820s is indicative of the sustained imaginative failings of those outside India (and in Gerard’s opinion those in Calcutta without direct experience of the mountains) when it came to the true scale of the Himalaya. This was a problem that could only be rectified with instruments especially conceived for the highest places and, after his experiences on Reo Purguil, Alexander Gerard ordered barometers to his own specification, ‘the scale which by means of a vernier shews 1/1000 of an inch [and] extends so low that altitudes of 24,000 feet may be measured by it.’<sup>109</sup> Although surveyors and explorers in the first half of the nineteenth century never reached altitudes anywhere near that high, they were becoming aware of the possibility that human beings and the apparatus of science had much higher yet to go.

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<sup>104</sup> Contemporary balloonists faced similar problems, needing instruments that would read even lower than mountain barometers to serve as altimeters. See Gerard L’Estrange Turner, *Nineteenth-Century Scientific Instruments* (London: Sotheby Publications, 1983), 234.

<sup>105</sup> Alexander Gerard, ‘Remarks upon Barometrical Heights’, NAI/SOI/Fdbk. 113, f132.

<sup>106</sup> *Ibid.*, f136.

<sup>107</sup> ‘On the Most Eligible Form for the Construction of a Portable Barometer’, *Gleanings in Science* 1, no. 11 (1829): 316.

<sup>108</sup> *Ibid.*, 316–17.

<sup>109</sup> Gerard, ‘Memoir of the Construction of a Map of Koonawur’, f202.

Theoretical limitations with barometers were also reflected in the way that the barometric formulas needed to be adjusted for the particular climates and latitudes of the Himalaya, and also to produce accurate readings for very high (and at the time the formulas had been devised, unprecedented) altitudes, a process that was ongoing in the first half of the nineteenth century. Raw measurements from barometers always needed to be corrected, especially for temperature, and for other causes of error relating to time of day, latitude, season, and extremes of local weather. One of the most common of ways of doing this was ‘Dr Maskelyne’s method’ which, as Gerard argued, ‘always gives the altitudes of very elevated places too little, because the equation for the latitude is not taken into account.’<sup>110</sup> Most critically, barometrical readings needed to be checked against equivalents taken at the same time of day from instruments kept at lower stations, ‘as without corresponding observations, the results of Barometrical measurement are likely to be erroneous.’<sup>111</sup> Calcutta and Saharanpur provided base measurements against which other variations in the higher mountains could be compared, such that refinements to these standards might mean recalculating earlier heights from the raw readings preserved in fieldbooks.<sup>112</sup> Figures for height were not static, and the surveyors’ original fieldbooks might prove more valuable than their worked-up and published calculations. As James Prinsep wrote in 1833, referring to the curious behavior of diurnal oscillation at extreme altitudes, ‘the determination of the zero or no oscillation altitude, may probably be obtainable from the journals of Captain Gerard or his brother, Dr. J. G. Gerard.’<sup>113</sup> Operating in the Himalaya did have some natural advantages, as ‘in these climates . . . the Barometer is so much more regular in its indications than in Europe,’ although this perhaps made establishing credibility among metropolitan instrument makers who were used to less stable barometrical outcomes even more difficult.<sup>114</sup>

Woefully inappropriate scales, unsatisfactory formulas, fragile tubes, and adjustment screws that were difficult to operate with frozen fingers and bulky gloves were merely part of a smorgasbord of problems with instruments designed in London or Paris by those with no experience of Himalayan conditions. As Alexander Gerard wrote, ‘it

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<sup>110</sup> Alexander Gerard, ‘Remarks upon Barometrical Heights’, NAI/SOI/Fdbk. 113, f128.

<sup>111</sup> James Herbert, ‘An Account of a Tour Made to Lay down the Course and Levels of the River Setlej’, *Asiatic Researches* 15 (1825): 414.

<sup>112</sup> Hodgson and Herbert, ‘An Account of Trigonometrical and Astronomical Operations’, 319–20.

<sup>113</sup> Patrick Gerard, ‘Abstract of a Meteorological Journal, Kept at Kotgarh’, ed. [James Prinsep], *Journal of the Asiatic Society of Bengal* 2 (1833): 619.

<sup>114</sup> Herbert, ‘An Account of a Tour’, 414.

appears to me that in regard to barometers and indeed most instruments, accuracy has generally been sacrificed to portability, and instruments of various kinds which are only suited for some parts of Europe are daily sent to India where they are often useless.<sup>115</sup> Similarly, in the first volume of the journal *Gleanings in Science*, edited by James Herbert and to which the Gerards and other Bengal Infantry surveyors were contributors, it was noted that 'it is extraordinary that in making instruments for the Indian market, the artists of London will not advert to the difference in the habits of the two countries.'<sup>116</sup> He was alluding, as well as the topographical factors, to the differing labor conditions in India. Himalayan surveyors had the ability to relatively cheaply co-opt local bodies to carry their instruments, and as Hodgson argued, in 'instruments intended for India solidity should be considered; we want those which will do their work effectually, & and are not anxious that they should be small & easily portable, as we can always here find means of carrying them.'<sup>117</sup> This emphasis on durability also implies the potential for rough treatment at the hands of careless porters. For professional, working surveyors – rather than gentlemen savants – ornamental or aesthetic qualities were of little value, and instruments only needed to be functional, without 'the bungling and expensive contrivances which are applied to instruments' of science, as fabricated by London artists, in the elaborate and useless finish given to them.'<sup>118</sup>

While lauding the local knowledge of displaced locations possessed by the Bengal infantrymen, Hodgson was explicit that this included an understanding 'not only of the language but of the customs, prejudices and peculiar feelings of the natives.'<sup>119</sup> The necessity of large parties of hill porters to carry instruments and supplies, and the omnipresence of Asian guides, brought a further dimension to the social performances required to establish the credibility of instrumental practices. Interactions between Himalayan peoples and instruments were usually recorded by the surveyors through standard tropes of curiosity, awe and superstition. These tropes allowed explorers, as Dane Kennedy has argued, to represent themselves as 'agents of a technologically inspired modernity.'<sup>120</sup> Alexander

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<sup>115</sup> Alexander Gerard, 'Remarks upon Barometrical Heights', NAI/SOI/Fdbk. 113, f135.

<sup>116</sup> 'On the Most Eligible Form for the Construction of a Portable Barometer', 314.

<sup>117</sup> John Hodgson, 'Field Book of May 1817', NAI/SOI/Fdbk. 91, f170.

<sup>118</sup> 'On the Most Eligible Form for the Construction of a Portable Barometer', 318.

<sup>119</sup> Hodgson to William Casement, 24 January 1829, NAI/SOI/DDn. 231, f261.

<sup>120</sup> Kennedy, *The Last Blank Spaces*, 157.

Gerard described the Tartars and their opinion of his collection of instruments in this manner: ‘they are very inquisitive and curious, and were constantly asking questions about the reflecting circle, sextants, barometers, and the astronomical telescope; the latter pleased them most, and I had frequently to shew the same objects to thirty or forty different people.’<sup>121</sup> It is difficult to know what the Tartars truly made of the surveyors’ instruments, and the way these interactions are recorded inevitably tell us far more about the Europeans than about their Asian assistants, even while reminding us of the imperial consequences for those being surveyed. In other moments, however, we are reminded that the European surveyors’ supposed superiority was far from assured in the extreme environment of the high Himalaya. As Alexander Gerard wrote of an ascent of the Yusu Pass:

We were so completely exhausted at first, that we halted every hundred yards; we observed the thermometer every minute almost, in order to show the people we were doing something. We purposed several times to turn back, and we certainly should have done so, had we not been ashamed before so many people, some of whom we got to accompany us by much entreaty.<sup>122</sup>

The brothers mask their weakness and bodily failings with the pretence of scientific practice, revealing that their dependence required them to maintain certain personas. Shame and an inability to risk loss of face motivated them to force their struggling bodies to keep moving upwards. The Gerards needed to convince the guides – whose enthusiasm for the task was already tenuous – that their suffering had a purpose, even if this purpose was not one that would necessarily have made sense to the guides. Himalayan scientific practices were not just social performances directed at Calcutta and London, and in this instance the instrumental readings were useless to European knowledge, functioning instead as an excuse for the altitude-struck surveyors to catch their breath without revealing their bodily debilitation.

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As a way into concluding, I now want to briefly consider a new sort of instrument – one specifically designed for measuring altitude – that was arriving in India just as the Gerards were struggling up Reo Purgyil; namely, Francis

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<sup>121</sup> Gerard, *Account of Koonawur*, 108–9.

<sup>122</sup> Lloyd and Gerard, *Narrative of a Journey*, Vol 2, 32-3.

Hyde Wollaston's 'thermometrical barometer' (hypsometer).<sup>123</sup> In tracing its fate in the Himalaya, we see a summation of the challenges – both real and rhetorical – facing the Bengal infantrymen in spaces in which instruments, inscriptions, and bodies were all prone to failures. In this period, taking rough altitude readings using a regular thermometer and tin shaving cup had sometimes been worthwhile in the absence of anything more suitable (as was practiced by the Gerards, Hodgson, Herbert and Webb). However, the growing necessity of precisely measuring altitude led to the emergence of specific boiling-point apparatuses that purported to increased accuracy and durability, of which the Wollaston was the most prominent example. The device took its temperature reading from the steam, which was more regular than the boiling water itself, and came fitted with a vernier, as can be seen in Fig. 2:

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<sup>123</sup> Francis John Hyde Wollaston, 'Description of a Thermometrical Barometer for Measuring Altitudes', *Philosophical Transactions of the Royal Society of London* 107 (1817): 183–96.

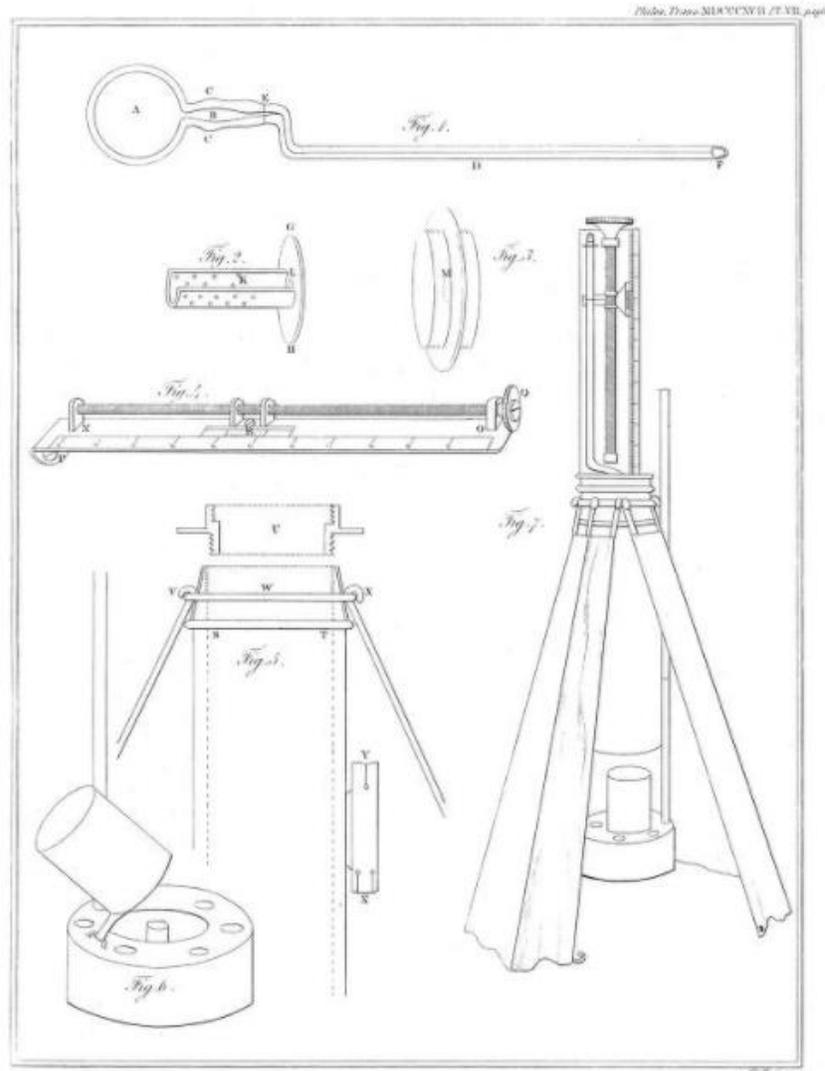


Fig. 2. Plate detailing Wollaston's Thermometrical Barometer (1817). Francis John Hyde Wollaston, 'Description of a Thermometrical Barometer for Measuring Altitudes', *Philosophical Transactions of the Royal Society of London* 107 (1817): 183–96. Image courtesy of The Royal Society.

In choosing the name 'thermometrical barometer,' Wollaston was perhaps deliberately making the claim that his device could compete directly with barometers in terms of accuracy, portability, and cost-effectiveness. Indeed, this device represents an attempt to evolve boiling-point thermometers from an instrument of approximation into an instrument that was both accurate and precise. One of Wollaston's main selling points was also that it was supposedly less prone to breaking than barometer tubes. An 1823 advertisement for this new thermometer in *The Calcutta Journal of Politics and General Literature* quoted extensively from Hodgson's misfortunes with broken

barometers in promoting its superiority.<sup>124</sup> Hodgson himself was initially optimistic when he heard about the thermometrical barometers, noting ‘I think that Dr. Woolaston's improved thermometer will supersede the mountain barometers altogether. It has every advantage.’<sup>125</sup> However, once he had actually had the chance to examine one, he became markedly less convinced, stating rather bluntly that: ‘Woolaston’s thermometrical barometers are of no use, you cannot take them out of their case without breaking, they will not do; besides there are none in Calcutta.’<sup>126</sup> This criticism was echoed by James Prinsep who thought that: ‘the error into which Wollaston fell was an attempt at too great sensibility. His instrument is beautiful in a laboratory, where it will serve to shew minute variations in the index error... but for rough work out of doors, accuracy must in some measure be sacrificed to strength and portability.’<sup>127</sup> Even in designing an instrument specifically intended to measure mountains *in situ*, the metropolitan artisan, based in London and at multiple removes from the spaces of the high mountains, could not imagine the world faced by Himalayan surveyors on a daily basis.

This was doubly apparent given that, as with barometers, Wollaston’s boiling-point devices suffered lingering issues with scales, legacies of the way the instrument was initially conceived and tested on Mount Snowdon in Wales. As Prinsep recorded, Wollaston and his assistants: ‘drew up a table of the value of the degrees between 214° and 202° in feet ... but, as this range only extends to an altitude of 5405 feet, it is evidently quite insufficient for the traveller in India, who may ascend to 18,000 feet and still see *Snowdons* towering above his head.’<sup>128</sup> Wollaston seemed to be aware of this issue, insisting that the ‘instrument, though adjusted now to my own particular use by the quantity of mercury in the thread, is capable of measuring any greater altitude, even Mt. Blanc or Chimborazo.’<sup>129</sup> Writing in 1825, however, Herbert suggested that the thermometrical barometer was still ‘not

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<sup>124</sup> ‘Mountain Barometers’, *The Calcutta Journal of Politics and General Literature* 1, no. 26 (1823): 415–16. The extracts cited were from Hodgson, ‘Journal of a Survey’.

<sup>125</sup> Hodgson and Herbert, ‘An Account of Trigonometrical and Astronomical Operations’, 209–10.

<sup>126</sup> Hodgson to Richard Wilcox, 28 August 1827, NAI/SOI/DDn. 220, f292.

<sup>127</sup> Prinsep, ‘Table for Ascertaining the Heights of Mountains’, 197.

<sup>128</sup> *Ibid.*

<sup>129</sup> Wollaston, ‘Description of a Thermometrical Barometer’, 192. For another case of an instrument on trial, see Nicky Reeves, ‘“To Demonstrate the Exactness of the Instrument”: Mountainside Trials of Precision in Scotland, 1774’, *Science in Context* 22, no. 3 (2009): 323–340.

made of sufficient extent as yet to comprehend within its range the boiling points' encountered in the Himalaya.<sup>130</sup> He also thought that the method of calibration described by Wollaston was impractical in the high mountains and seemed more suited to 'the easier journies through civilized Europe.'<sup>131</sup> From his Himalayan vantage point, Herbert was frustrated by the way that London savants and instrument makers were still struggling to address the need for instruments that had scales appropriate for mapping the upper reaches of the vertical globe, and that were rugged enough for Himalayan travel. With his direct experience of the Himalaya and position of distance, he had no qualms asserting this. This was a social performance itself, and in critiquing Wollaston, Herbert was simultaneously insisting on his own ability to produce reliable knowledge of the Himalayan frontier. The problems with fragility and scales were addressed in later models of the thermometrical barometer, and its eventual eligibility for the Himalaya is borne out by the way that Wollaston's devices were used extensively by English surgeon and botanist William Griffith (1810-45) and Victor Jacquemont in their Himalayan travels in the late 1820s and 1830s.<sup>132</sup> By this time the imaginative disconnect had been alleviated, and although many of the challenges of surveying in the mountains – especially using trigonometry – remained unsolved, as later nineteenth century stories only too clearly show, it was no longer impossible to imagine that the Himalaya held within its fastness the loftiest places on the globe.

This has been a story, above all, about limits: of bodies, of instruments, of senses, and not least, of imperial mastery. As surveying in the Himalaya became increasingly important, both to science and to the constitution of imperial frontiers, the instrumental practices used to measure the highest mountains of the globe came under increased scrutiny. Fragility was an ongoing concern, exacerbated by issues of remoteness that manifested themselves in a lack of replacements and limited options for repair. The surveyors' management of 'states of disrepair' was achieved with only varying degrees of success, and sometimes compromises between accuracy and practicality, and between name-brand and India-made instruments, were necessary in an environment hostile to the human body and

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<sup>130</sup> Herbert, 'An Account of a Tour', 412.

<sup>131</sup> *Ibid.*

<sup>132</sup> William Griffith, *Journals of Travels in Assam, Burma, Bootan, Affghanistan and the Neighbouring Countries* (Calcutta, 1847), 339; 371; Jacquemont, *Voyage Dans l'Inde*, Vol 1, 342-3. Griffith had both an old and an improved model of the Wollaston, and used them side-by-side. The use of thermometrical barometers was relatively short lived, and they were soon mostly superseded by aneroid barometers (first developed in the 1840s).

mind, as well as to the apparatuses of science. Surveyors insisted on the idiosyncrasy of the high mountains and the challenges to instrumental practice they faced within these spaces, in order to leverage their ability to overcome them for authority. There is undoubtedly much to be gained by examining ‘the integration of instrumentation with human performance and the establishment through such performances of trustworthy accounts of remote phenomena.’<sup>133</sup> However, we need to keep in mind the extent to which these social performances had multiple audiences, and played out against the ongoing challenges provided by a disconnect between the realities of instrumental practice as understood between not just metropole and colony, but between those in the mountains, those in Calcutta, and those in London. This imaginative discord manifested itself in debates around inadequate government-issue instruments, scales more suited to the Alps than the Himalaya, and untenable regulations around the submission of fieldbooks. Fieldbooks, barometers and thermometers nevertheless played key rhetorical roles and functions in establishing the reliability of knowledge produced in a hypoxic and sense-scrambling world, and a world which the British still little understood, but were beginning to fear did not provide the secure frontier its jagged aspect seemed to convey. Instruments, bodies and inscriptions, and the moments their limits were exceeded, thus provide a valuable window into to the scientific, political and imaginative constitution of the Himalaya. Through this window, we see surveyors struggling to assert their ability to produce reliable knowledge in a world in which one might stand at the height of the summit of Mont Blanc and still see Snowdons towering above.

Returning, one last time, to the Gerards where we left them high on Reo Purguil, we find that their claim of reaching a new high point on the vertical globe (and ultimately the credibility of their instruments and observations) was acknowledged, if perhaps a little grudgingly, by Alexander von Humboldt, whose altitude record on Chimborazo they had beaten (albeit only slightly).<sup>134</sup> The Gerards’ attitude to their achievement (shared, however poorly

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<sup>133</sup> Bourguet, Licoppe, and Sibum, *Instruments, Travel and Science*, 7.

<sup>134</sup> Humboldt could never quite bring himself to unequivocally accept this, noting the Gerards had gotten ‘as high, if not 117 feet higher, than I ascended the Chimborazo.’ Humboldt, *Views of Nature*, Vol 1, 236. This equivocation comes through in translation, see Alexander von Humboldt, *Ansichten Der Natur*, 3rd ed. (Stuttgart: J.G. Cotta, 1849), Vol 1, 56; 123; Vol 2, 50. Humboldt’s source was the overtly patriotic James Bell and John Bell, *Critical Researches in Philology and Geography* (Glasgow: James Brash & Co, 1824), 144. In 1827, Clement Johnson, by his own somewhat imprecise reckoning, probably reached the same point on Reo Purguil that the Gerards had. See Clement Johnson, ‘Journey Through the Himma-Leh Mountains to the Sources of the River Jumna, and Thence to the Confines of Chinese Tartary’, ed. W. Ainsworth, *The Journal of the Royal Geographical Society of London* 4 (1834): 58.

acknowledged, with their guides) nevertheless reveals something of an ambiguous attitude towards altitudinal supremacy at this time. Whether the Gerards high point was (as they thought) or was not (as we now know) a new altitude record does not perhaps matter all that much anyway, except in the context of the later nineteenth-century preoccupation with summiting higher and higher peaks, and a valorisation of height which has persisted until the present, remaining most explicitly embodied by Mount Everest.<sup>135</sup> The Gerards were keen to see their barometers read lower than fifteen inches, and undoubtedly later put considerable effort into instrumentally verifying their high point, indicating their willingness to engage in an essentially arbitrary imperial contest. That this record was nevertheless not as important to them than it might have been later in the century is apparent from the understated way Alexander Gerard records this ‘accomplishment’ in a technical memoir on mapmaking.<sup>136</sup> Perhaps most tellingly, nobody appears to have been overly anxious to rush out and beat their ‘record.’ Of course, reaching new heights was one thing, reliably instrumentally verifying them in a challenging and sense scrambling environment was another, and arguably where for Alexander Gerard the true contest lay.

Measuring altitude with any real degree of accuracy had never been necessary or even especially desirable before the late eighteenth century.<sup>137</sup> As the nineteenth century dawned, however, and the vertical globe began to be mapped out, accurate measurements of elevation were becoming a critical variable in many of the Humboldtian-infused sciences of the period, especially biogeography, altitude physiology, and geology.<sup>138</sup> As William Griffith argued, ‘the Botanist who travels without the means of determining these points, destroys half the value of his

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<sup>135</sup> Having lived in the Himalaya for millennia, it is not unlikely that indigenes had at some point been even higher (and the Inca had certainly been higher in the Andes). See footnote no. 11.

<sup>136</sup> The claim for reaching 19,411 feet was repeated in a posthumous version published in 1841, though again in an undramatic fashion. Gerard, *Account of Koonawur*, 176. Some years later (possibly in 1827), James Gerard likely reached an even higher altitude of 20,400 feet (measured by two barometers). Unlike for the ascent of Reo Purguil, details are obscure, perhaps explaining why this was never picked up by Humboldt or other later commentators). See James Gilbert Gerard, ‘Observations on the Spiti Valley and the Circumjacent Country within the Himalaya’, *Asiatic Researches* 18, no. 2 (1833): 254–55; Gerard, *Account of Koonawur*, 180.

<sup>137</sup> Robert Macfarlane, *Mountains of the Mind: A History of a Fascination* (London: Granta Books, 2003), 144.

<sup>138</sup> The term ‘Humboldtian’ usually indicates an emphasis on aesthetics and precise measurement, as well an impulse to study global phenomena comparatively. Though ‘Humboldtian’ is a modern scholarly term (coined by Susan Faye Cannon), the Bengal infantry surveyors featured in this article frequently cited Humboldt, and were at times both consciously and unconsciously Humboldtian in their approaches. Nevertheless, this is as much a story that features Humboldt as it is a Humboldtian one. See Michael Dettelbach, ‘The Face of Nature: Precise Measurement, Mapping, and Sensibility in the Work of Alexander von Humboldt’, *Studies in History and Philosophy of Biological & Biomedical Science* 30, no. 4 (1999): 473–504.

collections.’<sup>139</sup> The growing importance of altitude to scientific programs, and to mapping distribution in three dimensions, is evident in Fig. 3., which also enshrines the Gerards’ high point:

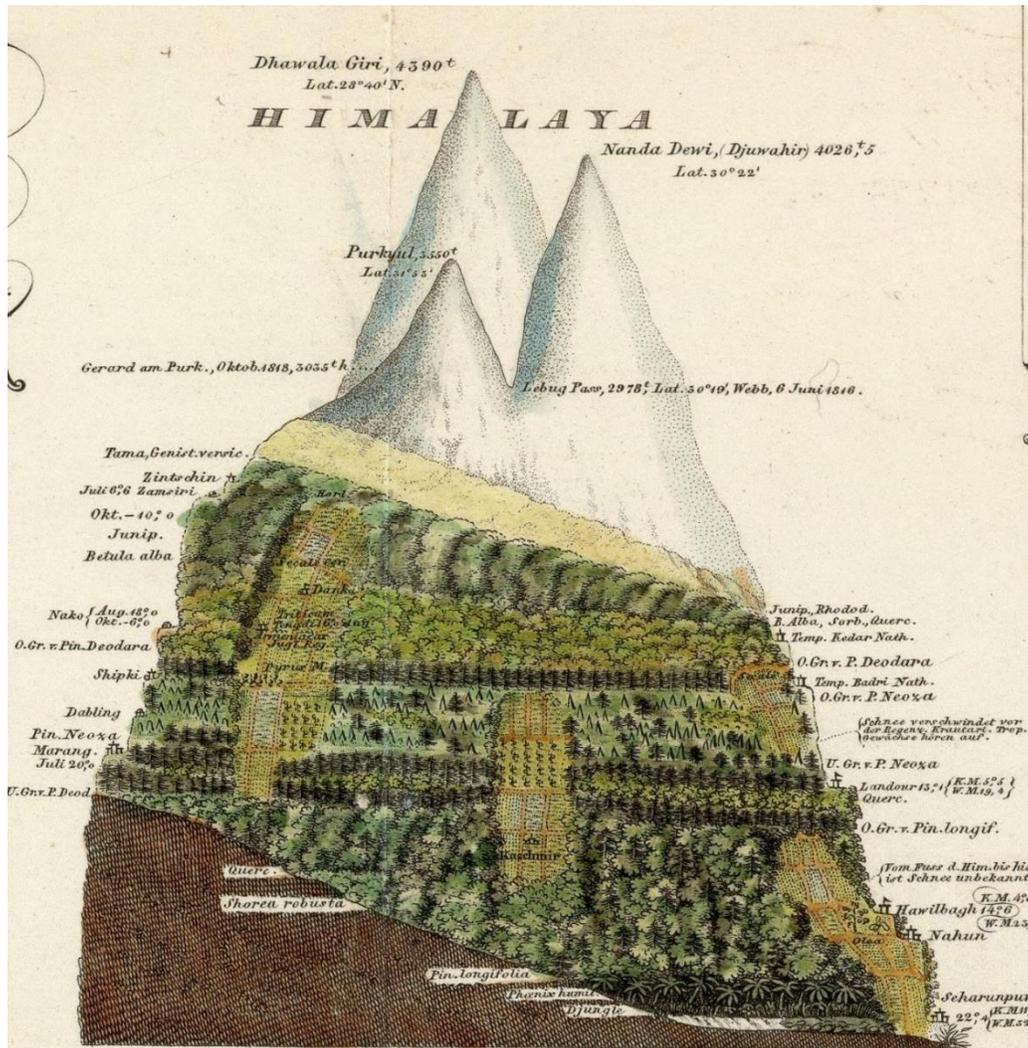


Fig. 3. Detail from ‘Umrisse der Pflanzengeographie’ [‘Outline of Plant Geography’]. This is part of a larger image comparing global biogeography, and was published in Dr. Heinrich Berghaus’ *Physikalischer Atlas* (Gotha: Justus Perthes, 1838). Such comparative tableaux of mountains (and often rivers), were increasingly popular across the first half of the nineteenth century, inspired by Humboldt’s own famous cross-sectional graphical representation of vegetation types on Chimborazo.<sup>140</sup> Everest was not yet known, and Dhaulagiri is here represented as the highest of the Himalaya (and hence the world). Reproduced with kind permission of the David Rumsey Map Collection ([www.davidrumsey.com](http://www.davidrumsey.com)).

Beyond the scientific interest, arguments were also more urgently being made for the ‘great practical utility, which may be derived to geography from a knowledge of the true position and elevation, of several snowy peaks in the

<sup>139</sup> Griffith, *Journals of Travels*, 429–30.

<sup>140</sup> Alexander von Humboldt and Aimé Bonpland, *Essai Sur La Géographie Des Plantes* (Paris: F. Schoell, 1805).

*Himāliāya* chain,' both for measuring back down to the plains and for securely drawing the mountains within the framework of imperial borderlands.<sup>141</sup> It was for both science and empire that the Bengal infantry surveyors lugged (or rather, employed Asian porters to lug) a panoply of fragile instruments into the Himalaya to accurately record the elevations, shapes, and locations of what were only just coming to be acknowledged were by far the highest mountains on the globe. Even if the scale was sometimes different, Himalayan surveyors were not, of course, alone in grappling with the problems of accurately measuring altitude, and similar issues with instruments were playing out in other mountains on other continents. Throughout the first decades of the nineteenth century, measuring Himalayan peaks also involved figuring out where they fit on a vertical globe that already featured Snowdon, Mont Blanc, and Chimborazo. In this sense, the necessity of mastering the unstable complex of instruments, inscriptions, and bodies to produce credible knowledge was attached to an increasing recognition of the commensurability of mountain environments. These concerns thus form part of a global story of mountain sciences and mountain borderlands, and increasing engagement with the verticality of the globe. Mountain science as understood in this period was, in other words, always global science.

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### **Author Biography**

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<sup>141</sup> William Webb, 'Memoir Relative to a Survey of Kumaon', *Asiatic Researches* 13 (1820): 294.