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## *Herschel, Humboldt and Imperial Science*

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In science, the nineteenth century is known as the beginning of a systematic approach to geophysics, an age when terrestrial magnetism, meteorology and other worldwide phenomena were studied for the first time on a large scale. International efforts to study the earth's climate, tides and magnetic field became common in the first half of this century, in large part because of the impetus given to the field by the work of Alexander von Humboldt. Due to Humboldt's influence, a system of geomagnetic observatories soon covered most of the European continent.<sup>1</sup> But one prominent nation remained outside of this system of observations. Despite Britain's inherent interest in geomagnetic studies (due to its maritime concerns) the laissez-faire attitudes of the British political system weakened efforts to subsidize state funded scientific projects. Not until the 1830s did Britain join with other European nations in the geophysical arena. This cooperation was beneficial to the science, as it brought not only Britain's considerable scientific resources to bear on the problem, but it also opened up Britain's imperial holdings as new stations to expand the observational system.

Humboldt's 1836 letter to the Duke of Sussex (President of the Royal Society), suggesting the establishment of geomagnetic observatories in British colonies, provides an initial point of reference for our investigations.<sup>2</sup> However, while welcomed by the scientific community, Humboldt's appeal

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1. By 1835, continental geomagnetic stations were operating at Altona, Augsburg, Berlin, Breda, Breslau, Copenhagen, Freiburg, Goettingen, Hanover, Leipzig, Marburg, Milan, Munich, St. Petersburg, Stockholm and Upsala. William Whewell, *History of the Inductive Sciences*. (London: John Parker & Son, 1857), III:50.

2. Alexander von Humboldt, "On the Advancement of the Knowledge of Terrestrial Magnetism, by the Establishment of Magnetic Stations and Corresponding Observations." *London and Edinburgh Philosophical Magazine* 9 (1836) 42-53. Specifically, Humboldt suggested that stations be established in New Holland (Australia), Ceylon, Mauritius, the Cape ("rendered illustrious by the labours of Sir John Herschel"), St. Helena, and North America.

alone failed to inspire action on the part of the British government. Only a domestic lobby composed of prominent British scientists could finally extract pecuniary support from the British state in 1839. The success of this lobby led to the launching of the “Magnetic Crusade,” a combination of an Antarctic expedition with colonial observatories to study geophysical sciences. Chief among the figures in the British lobby were Edward Sabine, Humphrey Lloyd and John Herschel. The activities of the latter especially were essential to the cause of Humboldtian science in the British empire.

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### *Herschel and Universal Science*

Like many scientists of his age, Herschel became interested in large scale, global observations in the physical sciences. Unlike Humboldt or Sabine, though, Herschel’s interest fit into an overall system of inductive universalism which he had defined years before. In his *Preliminary Discourse on the Study of Natural Philosophy* (1830) Herschel had expressed his belief in a system of universal induction which required large numbers of global observations over long periods of time in order to work out universal physical theories that applied to all of the particular observations by eliminating any temporary variations.<sup>3</sup> Tides, meteorology and geomagnetism provided ideal tests for his system, as they required large numbers of observations from all over the world in order to come up with a global theory that fit the phenomena. The Magnetic Crusade offered the opportunity to put such a plan of observation into action.

It is my thesis that Herschel’s contributions to the Magnetic Crusade were integral and essential. His philosophical beliefs concerning inductive science led him to add his own distinct and crucial additions to the plan of the Crusade, especially in the form of fixed colonial observatories. In so doing, he fulfilled the original intent of Humboldt’s observing plan and made it possible for scientific goals to be accomplished through the resources and structure of the British imperial system. Like the British empire, Herschel’s science was cosmopolitan and universalist. While his political and social connections were invaluable for the lobbying effort, he was not just its ‘celebrity spokesman,’ for Herschel had himself been harboring similar plans for many years which finally saw fruition in the Crusade.

### **Herschel’s Role**

Credit for Herschel’s contributions to the Crusade has not always been forthcoming. Many historians have neglected Herschel’s importance to the scientific shape of the project in favor of recognizing the importance of his

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3. *John Herschel, Preliminary Discourse on the Study of Natural Philosophy.* (New York: Johnson Reprint Corporation, 1966).

political connections. Herschel is sometimes portrayed as the public face who represented the lobby while others were doing the real organizational work. Jack Morrell and Arnold Thackray see Herschel as the “irreproachable spokesman” for the interests behind the Crusade, but call Sabine and Lloyd the “leading” figures in the lobby.<sup>4</sup> John Cawood identifies Sabine as the true “fanatic” motive force behind the lobby. While recognizing Herschel’s “scientific interest in the geomagnetic project” he holds that Herschel’s “true value to the magnetic lobby [was] in his prestige and position.”<sup>5</sup> Cawood is correct that Herschel’s position in society did give him (and the lobby) special access to government officials, but to ignore Herschel’s scientific contributions to the Crusade is to misrepresent his true role.

Herschel became the primary reason that the Crusade expanded beyond an Antarctic expedition to include fixed stations for observations around the world. After the publication of the *Preliminary Discourse*, Herschel had pursued his inductive ideas. His interest in global geomagnetic observations can be traced to this particular view of universal induction, which held that while general propositions were by their nature only probable truths when applied beyond the range of the instances from which they were derived, the more frequently they were tested in other instances the more their probability approached certainty.<sup>6</sup> For terrestrial magnetism, Herschel proposed the need for stations to acquire continuous observations because variations in the earth’s magnetic field could only be detected over many years. He also held that the data must be collected simultaneously at various stations, in order to treat the variations globally. He believed that with enough data from particular points, a full theory of geomagnetism could be worked out for the whole world. To Lloyd, Herschel wrote that:

The secular variation of the constant elements in a general theory of Terr[estrial] Magnetism is one of indispensable importance and *can* only be obtained by observations of extreme precision carried on for many years. Were they known for every point on the globe we might of course by their aid bring all ancient and modern obs[ervations] to one epoch.<sup>7</sup>

The proposal to establish the stations changed the very nature of the Crusade, making it more than just another temporary magnetic survey. It also tied the Crusade more closely to the British imperial system than an expedition alone could have done. Eventually the Crusade was internationalized and provided the basis for continuous physical observations around the world. All

4. Jack Morrell and Arnold Thackray. *Gentlemen of Science*. (Oxford: Clarendon Press, 1981), 369, 359.

5. John Cawood, “The Magnetic Crusade: Science and Politics in early Victorian England.” *Isis* 70 (1979), 507.

6. Herschel to Stewart, 1834. “John Herschel Letter.” *South African Libraries* 7 (1940), 138-54.

7. Herschel to Lloyd, November 5, 1838. (Royal Society).

of these elements of the final plan of the Crusade can be traced back to Herschel's involvement.

Humboldt's influence on Herschel and on the ideas behind the lobby during this period is evident. Herschel later declared that no other man of science was "more versatile in genius, more indefatigable in application to all kinds of learning, more energetic in action, or more ardent in inquiry."<sup>8</sup> Humboldt's 1836 letter clearly gave impetus to the ideas that lay behind the Magnetic Crusade. Yet to call the British foray into colonial observing a "direct consequence" of that letter (as Malin and Barraclough have done) ignores three years of lobbying and development of the idea on the British side.<sup>9</sup> Without the inductive philosophy of Herschel and his commitment to global observing, the Crusade might have ended up being just another one-time scientific expedition to the South Seas.

Herschel was certainly drawing upon a Humboldtian observational tradition in his plans for fixed stations.<sup>10</sup> But as Cawood has pointed out, Humboldt's contribution was inspirational rather than practical.<sup>11</sup> The difference lay in Herschel's ability to combine his own sociopolitical influence with his philosophical beliefs. Herschel's role in the Crusade was the key to bringing about this system of stations in the British empire in 1839 where Humboldt had failed in 1836. Herschel's plan required continuous observations over a long period of time, and thus the existence of permanent structures for observatories.

The events around the Magnetic Crusade were not the first time Herschel had tried to put his system of observing into operation. He had been active in plans to set up an extensive series of colonial geophysical observations for some years before the Crusade. The years he spent in South Africa (1833-1838) were a formative period for these actions. Here he particularly took an interest in meteorology. One of his first actions when arriving at the Cape was to make a series of meteorological observations.<sup>12</sup> In 1835, he had written to William Henry Smythe, recommending a new plan for hourly worldwide meteorological observations on four predetermined days each year all over the world. He was planning to participate from the Cape, and he hoped it was undertaken in India, New South Wales, Mauritius, and in many other

8. Herschel, "Humboldt's Kosmos." *Edinburgh Review* 87 (January 1848), 91.

9. S.R.C. Malin and D.R. Barraclough, "Humboldt and the Earth's Magnetic Field," *Quarterly Journal of the Royal Astronomical Society*, 32:3 (1991), 279.

10. Steven Ruskin argues that Herschel followed the pattern of "Humboldtian traveling" during his early days, and that his trip to the Cape of Good Hope can be seen in this light as well. Steven Ruskin, *John Herschel's Cape Voyage*. (Burlington: Ashgate, 2004), 12-36.

11. John Cawood, "Comments," in *Human Applications of Scientific Advance*. (Edinburgh: Edinburgh University Press, 1978), 146.

12. Herschel to Paine, August 26, 1836. (University of Texas, Austin).

localities.<sup>13</sup> In 1837, he gained the cooperation of Adolph Quetelet for a series of simultaneous meteorological observations between Europe and the Cape.<sup>14</sup>

While at the Cape, Herschel also collected meteorological observations from around the world, receiving reports from India, Geneva, Guyana, Mauritius, Turin, Albany, Port Arthur, Boston, Tasmania, Bermuda and Brussels. In 1836 he became an honorary member of the British Meteorological Society. He also intended for the system of observations to continue even after his departure, publishing “Instructions for Making and Registering Meteorological Observations at various Stations in South Africa” in 1838.<sup>15</sup>

Herschel also saw the tides as a field worthy of study, especially as his friend William Whewell was making a study of them. Herschel assisted Whewell by gathering tidal observations both at the Cape and from his brother-in-law in Canton.<sup>16</sup> Only in the field of geomagnetism did Herschel fail to make any observations at the Cape. Writing to his aunt Caroline in 1836, he explained that while he had heard of Carl Gauss’ new method for making geomagnetic observations, he lacked the necessary equipment to carry them out in Africa.<sup>17</sup>

Herschel saw the value in setting up physical observatories around the world for geophysical observations. In 1835 (a year before Humboldt’s letter to the Royal Society) Herschel wrote extensively to Captain Francis Beaufort, the Royal Hydrographer, about the nature of such physical observatories. Complaining about the proliferation of colonial astronomical observatories, Herschel maintained that small, local observatories could contribute little to astronomy. Rather, he believed that such establishments should be converted to physical observatories to make observations concerning magnetic intensity and direction, meteorology and the tides. Such observatories could also serve as centers to propagate accurate standards of weights and measures in the colonies.<sup>18</sup> These goals were some of those which he had laid out for observing stations in the *Preliminary Discourse* in 1830.

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13. Herschel; to Smythe, May 10, 1835. (Royal Society).

14. Herschel to Quetelet, June 15, 1837. (American Philosophical Society).

15. John Herschel, “Instructions for Making and Registering Meteorological Observations in South Africa.” (Meteorological Committee of the South African Literary and Philosophical Institution, 1838).

16. Herschel to Stewart, November 25, 1835. David S. Evans, editor. *Herschel at the Cape*. (Austin: University of Texas Press, 1969); Herschel to Whewell, July 22, 1837 (Royal Society).

17. Herschel to Caroline, March 8, 1836. Here Herschel apparently forgot an earlier promise to Quetelet. Writing in 1831, Herschel had expressed interest in Quetelet’s new magnetic observations, and vowed to “make a case of magnets a principal feature in my list of apparatus,” should he travel again. Herschel to Quetelet, December 19, 1831. (American Philosophical Society).

18. Herschel to Beaufort, October 11, 1835. (Royal Society).

Although he was unable to make geomagnetic observations while in Africa, Herschel did busy himself helping to set up colonial observatories around the world to make geomagnetic, tidal and meteorological observations. Here he joined with Humboldt who had also urged the establishment of observatories around the world for geomagnetic readings. Herschel differed from Humboldt in that he believed that the observatories should focus on all geophysical fields, not just geomagnetism.<sup>19</sup> In 1836 Herschel played a role in the establishment of a new observatory in Bombay. In 1837 he advised George Gipps to set up a physical observatory in Australia for tidal, magnetic and meteorological observations, rather than an astronomic one.<sup>20</sup> Similarly in mid-1838 he advised Captain Beaufort on establishing a physical observatory on Mauritius.<sup>21</sup>

Herschel's part in setting up observatories to provide the raw data for his universal inductions brought him to change his mind about the individual nature of scientific activity and the need for state involvement. In 1831, he had argued that public funding for science was more than adequate.<sup>22</sup> Now realizing the value of the empire in the task of setting up colonial stations, Herschel worked to bring state support into science. Such assistance not only provided the necessary sites for observing stations, but also crucial coordination for simultaneous observing. Herschel saw the state as the patron of science, but did not believe that it was necessarily required to back all scientific ventures.

With the beginning of the lobby and a chance at state support for his plans, Herschel reached one of the critical points in his scientific career. Up to that point, he had helped to set up observatories around the world in a private capacity by advising and writing letters of support. But his overall plan of a more extensive global system of stations for the purpose of observing seemed to be out of reach. In 1835 when he had laid out his plans for physical observatories to Captain Beaufort, he had ended his letter by commenting that "perhaps all of this is dreaming."<sup>23</sup> Writing to James Forbes in 1836, he had expressed his desire to see a new class of physical observatories established, but regretted that he had "not now the time to enter into" such a project.<sup>24</sup> His work in South Africa kept him too busy to become more involved in physical observations, but on his return to England in the spring of 1838, he was finally able to devote his time to it.

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19. Herschel to Forbes, November 15, 1836. (St. Andrew's University Library).

20. Herschel to Gipps, December 27, 1837. (Royal Society).

21. Herschel to Beaufort, June 29, 1838; Herschel to Beaufort, July 22, 1838. (Royal Society).

22. Herschel to Hussey, August 2/3, 1831. (Royal Society).

23. Herschel to Beaufort, October 11, 1835. (Royal Society).

24. Herschel to Forbes, November 15, 1836. (St. Andrew's University Library).

Thus Herschel already harbored a desire to create a system of global observatories in the British colonies by the summer of 1838, before the lobby for the Crusade even began. While in Africa, he came to accept the utility of establishing observing stations in British colonies. Eventually he embraced the involvement of the state in science as necessary when he looked to the British colonial world to supply sites for observatories. Accepting that his individual efforts were insufficient to set up enough stations to furnish the observations which could provide inductive legitimacy, he decided to go directly to the British Government. In the absence of the now dissolved Board of Longitude, he appealed through another institution which had an interest in geomagnetism, the Admiralty.

In an important letter of June 1838, shortly after his return from Africa, Herschel laid out his proposal to his friend Captain Beaufort. Citing the recent success of Humboldt's continental geomagnetic stations, he proposed the establishment of a similar system of observations "over the whole surface of the globe, and especially of establishing permanent magnetic stations at the Cape, in India, Australia and other points within the range of British superintendence." Herschel stressed the need for stations in addition to the new voyages of discovery which had become common in recent years. He particularly concentrated on the field of geomagnetism, arguing the importance of a knowledge of terrestrial magnetism and urging observations in India and the Southern hemisphere, where less was known. These observations corresponded to regions of British colonial expansion.<sup>25</sup>

This letter is important because it shows that Herschel had already reached the conclusion that a global system of observation points was necessary to provide data, even before British scientists began to lobby for the same objective. He even appealed to Humboldt to help him in his private efforts to bring the British government on board. He hoped that Humboldt would back his plan for a series of colonial observatories at the Cape, India, Australia and Mauritius (or "in short as many stations as possible in the English colonial possessions") in correspondence with those in Europe.<sup>26</sup> While Herschel felt he had every reason to hope that his suggestion might be adopted, his private appeal came to nothing. But his failure to convince the Admiralty to go along with his plan in the summer of 1838 provides a clue as to why Herschel joined the lobby for the Magnetic Crusade that Fall.

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### *Summary*

In the lobby for the Crusade, Herschel's philosophical system and his influence helped to push the stations into an equal position with the expedi-

25. Herschel to Beaufort, June 29, 1838. (Royal Society).

26. Herschel to Humboldt, July 31, 1838. (Royal Society).

tion in the overall project. Twice he went out of his way to keep them there even when the lobby was having troubles. He also served as a liaison between the scientific lobby and the East India Company, which was interested in establishing its own colonial observing posts in the subcontinent.<sup>27</sup> The addition of East India Company stations completed the worldwide scope of the project.<sup>28</sup>

The establishment of the stations not only began the global data collection for which Herschel had been pushing since the previous year, it also helped to tie Britain into the existing international community of magnetic observatories. Long after the Antarctic expedition was over, data continued to be generated by the stations in the British colonies. In the months after the launch of the Crusade, Herschel worked to expand these stations beyond the few originally approved by the government. In July 1839, Sabine reported on one of Herschel's latest attempts for an observatory in Egypt. "You are aware that we have written to the pasha of Egypt," he exclaimed to Lloyd. "This is Herschel's doing."<sup>29</sup>

The expansion of the Crusade to include fixed observatories also tied the scientific venture more closely to the imperial apparatus of the British state. This element benefited the project both by helping to secure government support and extending the number of stations and the places where they could be located. Government backing insured continued funding for the scientific project, while the state gained prestige and scientific information on tides, navigation and climate that could benefit imperial expansion. Indeed, the Crusade fit nicely into the existing imperial policy on science. Already the Admiralty was sponsoring geographical surveys of India; in the fall of 1838, governors of British colonies were asked to begin keeping records on storms and winds.<sup>30</sup>

That the idea for such an extensive system of stations originated with Herschel seems clear. Neither Lloyd nor Sabine had been willing to suggest such a plan when the lobby began.<sup>31</sup> The addition of the observatories to the Cru-

27. Herschel to Robertson, August 6, 1838. (Royal Society).

28. Lloyd to Sabine, November 30, 1839. (Public Record Office). Observatories were established at Simla, Madras and Bombay. Whewell, III:50.

29. Sabine to Lloyd, July 5, 1839. (Royal Society). See Herschel to Northampton, August 1, 1839. (Royal Society): "Resolved - that the President be requested to apply to the Secretary of State for Foreign Affairs for a letter introducing & recommending the magnetic circular of this society to the notice of his highness the pasha of Egypt, to be delivered with that circular to his highness."

30. Circular to Governors of British Colonies, November 29, 1838. Matthew Maury. *Explanations and Sailing Directions to accompany the Wind and Current Charts*. (Washington: Harris, 1858), 27.

31. Lloyd to Herschel, August 4, 1838; Sabine to Herschel, August 4, 1838. (Royal Society)

sade was an act supported and defended by Herschel. Sabine later came to see them as the more important half despite his affection for a naval expedition. Later he wrote to Lloyd:

I believe with you that the results of the system of fixed observatories will eventually be even more important than those of the naval expedition, and that, particularly, establishment of the observatories will constitute in the view of our successors as of much more consequence than the expedition & its results.<sup>32</sup>

Sabine now embraced the observatories despite their lower profile.<sup>33</sup> Herschel was still operating in the same vein as he had been when he had helped to set up meteorological observatories while in Africa, still looking for ways to universalize induction to find physical theory. By setting up observatories which could conduct global observations across significant periods of time, Herschel thought that he could find a solution to deriving general, universal laws from particular data. Herschel's participation in the Magnetic Crusade can be seen as a continuation of the work he had been doing for years before. Inspired by his belief that universal knowledge was possible and that the weaknesses of induction could be eliminated with enough physical data spread out over time and place, he pursued the goal of founding stations around the world for the purposes of simultaneous physical observations.

In a letter to François Arago of October 1839, Herschel spelled out his reasons and motives for his participation in the Crusade. He saw this occasion as a truly unique moment in the history of science to extend physical observations on a global scale, an

opportunity such as may probably never again occur of fixing for future ages – so to speak at a blow...the magnetic data...upon a scale which may be said without exaggeration to embrace the whole globe and which shall spread over a period sufficiently long to give complete room for the elimination of all that is accidental and temporary.<sup>34</sup>

Hoping to gain French assistance in setting up an observatory in Algiers, Herschel described his recent successes. In addition to the stations set up by the expedition, new stations had been founded in India. Applications had been made for others at Aden and Singapore, and Herschel hoped that the USA would soon become involved. Britain was now connected to an international system of observing and Herschel's dream of inductive certainty and

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32. Sabine to Lloyd, December 20, 1839. (Royal Society).

33. "I am fully persuaded of myself, that except by three or four individuals the importance of the magnetic observatories is not yet known or felt in this country; and that *that* is the reason why the branch of the magnetic researches has been so inadequately noticed." Sabine to Herschel, December 16, 1839. (Royal Society).

34. Herschel to Arago, October 30, 1839. (University of Texas, Austin).

its need for simultaneous, continuous observations around the world was becoming a reality.

Herschel was still thinking on a global scale. While the Crusade may have been sold to the British Government as a boon to navigation and commerce, in many ways it represented science's use of the apparatus of state for its own ends. For Herschel, the Magnetic Crusade provided an opportunity to fulfill the scientific quest which he had begun years earlier in his *Preliminary Discourse* with its proposal to use stations to collect worldwide data which could be transmitted back to develop new theories. This plan had continued in his 1835 letter to Captain Beaufort concerning physical observatories and in his 1838 appeal to the Admiralty to set up observatories in British colonies.<sup>35</sup> His plans finally came to fruition through the fixed stations established by the Magnetic Crusade, which set up the first of dozens of points around the world connected back into Humboldt's continental observatories in a single system. As Whewell later summarized, "such a scheme, combining worldwide extent with the singleness of action of an individual mind, [was] hitherto without parallel."<sup>36</sup> Thus Herschel fulfilled Humboldt's colonial plan while working towards his own goals for a new universal inductive science.

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35. Herschel was obviously impressed by his 1835 letter to Beaufort. As late as 1842 he referred Wheatstone to it as a reference for the necessary qualities of physical observatories. Herschel to Wheatstone, June 17, 1842. (Royal Society).

36. Whewell, III:51.