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### Imperialism, Mining, and the Birth of Modern Geology in 19<sup>th</sup> century China

In 1910, Zhang Xiangwen 張相文 (1867-1933) and other members of the Chinese Geological Society (中国地学会) published the first Chinese periodical devoted to geography and geology, *Dixue zazhi* 地學雜誌 (*Geographical Magazine*). The bulk of the introductory remarks in the first issue, however, focus not on the finer points of mineral identification, or even the most recent geological theories, but conjures up a social Darwinian vision of violent conflicts between nations and the survival of the fittest, or at least of the geographically most ideally situated. “Human life depends upon the great earth. The collected nations plot their own survival,” Zhang begins, “But evolution is violent. The circumstances will not allow for each country to guard and seal its own borders. Countries mutually attempt to steal territory...Geography’s influence depends on the country, and the misfortune it causes also extends to the race. These things are universal examples of natural selection.”

“In recent ages, the imperialists have come across the seas to seek new ground and colonize,” Zhang continues, “Our country is large and contains a wealth of goods. We face strong enemies; we have failed at foreign relations; on the frontiers matters grow more urgent daily.”<sup>1</sup> The litany of China’s ills continues, and it is not until the second half of the introduction that Zhang connects geographical and geological research with

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<sup>1</sup> Zhang Xiangwen 張相文, "Zhongguo dixue hui qi 中國地學會啟," *地学杂志* 1910.

China's dire straits. Until 1910, no formal organization had formed to research and collect information on the mountains, rivers, frontier regions, means of transportation, and other areas of geography with practical applications. A geographical society, Zhang argues in the preface, was long overdue.<sup>2</sup>

The sense of dire urgency should come as no surprise, for the *Geographical Magazine* went to print in an era of revolutions and great political turmoil for China. Even as the Zhang focuses on problems and issues specific to China in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, however, his language evokes a pre-WWI internationalism. Zhang ends with the formation of a society of gentlemen for the geographical study, but begins broadly with humans and nations struggling for survival and territorial integrity. By using Yan Fu's translated terms for evolution and natural selection, Zhang places geology firmly in a pre-WWI global discourse of social Darwinian struggle and national / international competition. The ubiquity of such discourse has a certain irony – even as writers from Europe to Asia called for national awakening, in this specific case, the further study of geographical issues relevant to the Chinese resistance against imperialism, the language they employed erased boundaries and placed all on a social Darwinian battleground. The quotes from the preface of the *Geographical Magazine* would not have appeared out of place in any number of periodicals and pamphlets from

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<sup>2</sup> In modern Chinese usage, geology is 地質 *dizhi*, whereas 地學 *dixue*, the term often used in these translations, according to the 汉语大辞典 *Hanyu da cidian* (*Dictionary of the Chinese Language*), originally referred to either geography (地理) or geology (地质), and currently refers to the overarching category of studies involving the earth, including everything from paleontology, oceanography, to geophysics. If this morass of terms seem at first glance confusing, however, keep in mind all the names, sub-categories and headings for geology in the 19<sup>th</sup> century in the West, including geography, mineralogy, and geognosie.

pre-war Germany, for example. Nor was the usage of metaphors of struggle and competition to describe the exploitation of mineral resources unique to the Chinese case.

In most accounts, modern Chinese geology began with European pioneers of geology in China in the 19<sup>th</sup> century, such luminaries of the field as the American geologist Raphael Pumpelly, the German Ferdinand von Richthofen, the French J.A. Deprat and others, who traveled and conducted research in China in the years following the second Opium War.<sup>3</sup> Conventional accounts trace modern Chinese geology to 1912, when the Bureau of Agriculture and Commerce (农商部) founded a geology department, and 1913, when the Bureau opened a geological research institute at Beijing University.<sup>4</sup> These grand titles, however, belie actual conditions – a German professor, Herr Solger, imported to teach courses in geology at the Tong Wen Guan (同文館 the predecessor to Beijing University), sat idle for lack of interest, and when the British trained geologist Ding Wenjiang arrived at the geology department at Beijing University in 1913, he found one room, empty of books, maps, and other tools of geological research.<sup>5</sup> From such inauspicious beginnings, this narrative of modern geology in China goes on to greater triumphs. In 1919, Ding led the first national geological survey of China.

Missing from the above trajectory of modern geology, however, is the 19<sup>th</sup> century and the intersection of imperialism, geology, and China's first modern mines and attempts at industrialization. By pushing back the time frame, an entirely different picture emerges. In this alternative narrative, the picture of struggle and resource exploitation painted by Zhang in the preface to the *Geographical Magazine* comes as one endpoint to

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<sup>3</sup> 赵荣, 杨正秦, 《中国地理学史》, 商务印书馆, 1998。8。

<sup>4</sup> 地质学史论丛, 北京, 地质出版社, 2002。3。

<sup>5</sup> Furth, 37-39.

a century of scientific and technological adoption and adaptation. By 1910, the group of literati gentlemen who joined together to form a scientific society had already rhetorically joined an international group. From Berlin to Shanghai, government officials and men with geological interests saw the importance of exploiting natural resources such as coal and framed their scientific interest in social Darwinian terms.

The first state sponsored geological mapping took place in England and Wales in 1835, in Germany from the 1840 until the early 20<sup>th</sup> century, and in France in 1868.<sup>6</sup> For Oldroyd, these geological surveys represented a Foucaultian effort to bring the earth under human control. They also served very practical purposes. According to Robert Stafford, from the 1830s onward, “the science of geology enjoyed a remarkable vogue as an instrument of imperial development and a component of the more widespread phenomenon of Britain’s economic, cultural, and technological expansion.”<sup>7</sup> The London Geological Society, founded in 1807, enthusiastically encouraged British officials overseas to contribute to the new discipline. Henry De La Beche, director-general of the Ordnance Survey, which oversaw the Geological Survey of Great Britain, established a mining Record Office as well as a Museum of Practical Geology. British interests in Chinese geology reached a critical juncture in the First Opium War (1839-42), when the deployment of steam warships revealed shortage of coal in Chinese waters. According to Stafford, “depots were established for English fuel, but as requirements outran supply, coal exploration was stimulated throughout the Indian Ocean and attention was turned to

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<sup>6</sup> David Oldroyd, *Thinking About the Earth: A History of Ideas in Geology*, ed. David Oldroyd, *Studies in the History and Philosophy of the Earth Sciences* (London, 1996). P124.

<sup>7</sup> Robert Stafford, "Geological Surveys, Mineral Discoveries, and British Expansion, 1835-71.," *The Journal of Imperial and Commonwealth History* XII (May 1984, 1984). 5.

the possible exploitation of Chinese deposits. The geologists were quick to offer advice on this strategic subject in order to display the usefulness of their science.”<sup>8</sup> In the years following the First Opium War, the Royal Society and the Geological Society stepped up efforts to investigate and analyze Chinese resources. In the late 1860s, another British group, the Shanghai Chamber of Commerce, sponsored the Baron Ferdinand von Richthofen’s expeditions in China, in return for detailed reports on coal, metal, and other mineral mining conditions in the various provinces.

In the same time period, following the opening of treaty port cities on the Chinese coast, a group of British and American protestant missionaries made great headway in the arduous effort to translate Western science into Chinese. Following its founding in 1795, the London Missionary Society was one of a number of Protestant missionary groups which played a key role in China in the 19<sup>th</sup> century. In the services of the LMS, Robert Morrison began the translation effort by assembling a sizeable library of Chinese works on mathematics and the *material medica*.<sup>9</sup> Dr. Benjamin Hobson compiled and translated the *Treatise of Natural Philosophy (Gezhi Xinbian, 1851)*. Other respected missionaries such as Alexander Wylie, Joseph Edkins, and John Fryer worked together with Chinese collaborators to produce translations related to science. Their efforts include the *Shanghai Serial (Liuhe Congtan)*, and the *Primers for Science Studies (Gezhi qimeng)*. These works list geology as one of the science fields. The *Primers for Science Studies*,

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<sup>8</sup> Robert Stafford, *Scientist of Empire: Sir Roderick Murchison, scientific exploration and Victorian imperialism* (Cambridge, 1989). 132.

<sup>9</sup> For a detailed discussion on the Protestant missionary efforts in China, see the chapter in Benjamin Elman, *On Their Own Terms: Science in China, 1550-1900*. (Cambridge, 2005). 283-5.

for example, translated Archibald Geikie's famous English textbook into a section on geology (*dixue*).<sup>10</sup>

Most of the references in these 19<sup>th</sup> century protestant translations refer to geology in the context of mining and mineral classification. In these areas, however, geology, although not referred to as such by the Chinese before the introduction of Western geology, has ancient antecedents in China. Moreover, well before the establishment of a geological research institute at Beijing University in 1913, the Qing state and individual officials recognized the importance of mineral surveys, and sought the resulting economic benefits, much as 19<sup>th</sup> century European states had done so around the same period of time. Chinese alchemists, heavily influenced by the Daoist tradition and the search for an elixir of eternal life, long experimented with various metals and minerals. If these experimentations frequently did not turn out well for these alchemists and Daoist acolytes, resulting often in arsenic, mercury and other poisoning and death, they nevertheless helped with the classification of metals and minerals and placed them with a *materia medica* tradition, as well as, the Daoist cannon. Along a different track, large-scale Chinese mining developed while Europe still languished in the Dark Ages. According to Robert Hartwell's study, "the development of ferrous mining and metallurgy in China between 750 and 1100 was historically unprecedented. Between 806-1078, *per capita* yields of pig iron increased over six-fold, and by the latter year Northern Sung mines and smelters were producing at least 125,000 tons annually."<sup>11</sup> During this period of rapid economic expansion, large industrial centers in the Northeast also

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<sup>10</sup> Ibid., Appedix 5, 428.

<sup>11</sup> Robert Hartwell, "A Cycle of Economic Change in Imperial China: Coal and Iron in Northeast China, 750-1350." 104.

supplied coal for heating to the capital of Kaifeng. These numbers and facts do not necessarily imply that China “had geology all along.” They do, however, serve as warning when demarcating the dates of geology’s founding in China, especially given the trickiness of the term “geology” to begin with, even in a purely European context.

Geology the science may have emerged in the 19<sup>th</sup> century, but its components, ranging from mining engineering to mineralogy, predated its founding and continued to influence its development.

What attracted the first European geologists to explore China, however, was not its alchemical tradition nor its history, but its riches underground. From 1868-1872 the Prussian geologist Baron Ferdinand von Richthofen traveled throughout China in seven expeditions. These travels laid the foundation for his later five-volume work on China, which served as the standard for European scholarship on Chinese geology well into the 20<sup>th</sup> century. As Richthofen conducted his research, he witnessed great poverty and decline in various parts of the Chinese empire, and he arrived at his own theories of causation. Backwardness in northern China, he argued, resulted from the deterioration of climate, likely the consequence of deforestation. The sad state of transportation prevented efficient use of labor and exploitation of the region’s coal resources, while overpopulation exacerbated these existing conditions. Competition from foreign trade annihilated local commerce. Finally, devastating rebellions decimated the economy and the population.<sup>12</sup> If at times Richthofen spouted the usual racism of a gentleman of his times, he was also reasonably fair in his assessment of the negative aspects of imperialism. Cheap foreign manufactured goods ruined a number of traditional trades. He

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<sup>12</sup> Richthofen, *Baron Richthofen's letters*. 55-57.

wrote scornfully of Europeans who isolated themselves in the treaty ports, leading lives entirely divorced from the country where they now resided. For Richthofen, however, the solution to these problems lay not in retrenchment in tradition but in the adoption of the newest technology – the railroad, telegraph and all the trappings of industrialization and modernity. These harbingers of progress depended upon a key resource: coal.

Unlike his famed predecessor Alexander von Humboldt, Richthofen, though a nobleman, lacked the fortune to fund his own expeditions.<sup>13</sup> The Bank of California sponsored the first year of his China research. Thereafter, Richthofen was sponsored by the Shanghai Chamber of Commerce. His financial backing partly explains Richthofen's practical interests, particularly in locating and assessing coal deposits, and why visits to mines occupied so much of his time and energy. At the same time, his words show that he himself recognized and approved of the applications of his geological assessments and saw them as inevitable modernization heralded by European arrival. He wrote in late 1868, at the beginning of his journeys, "My goal is the geological research of the mountains and the investigation of some coal deposits, which from the few reports of eyewitnesses, belong with the best and by their location could become very important. Should they be, as I expect, I hope that they will be in operation in the not too distant future and that the first railroad in China will be built in Shandong."<sup>14</sup>

On his first extended outing in China, from March to May 1869 in Shandong province, Richthofen missed the gravestone of Confucius and the venerated Taishan.

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<sup>13</sup> "China Cartographica: Chinesische Kartenschaetze und europaeische Forschungsdokumente: Ausstellung anlaesslich des 150. Geburtstages des Chinaforschers Ferdinand von Richthofen" (paper presented at the Staatsbibliothek Preussischer Kulturbesitz, Berlin, 1984). 87.

<sup>14</sup> Richthofen, Tagebücher. VI. 29.

Instead, he oriented his geological survey around the reported location of coal deposits. Taking a trip on the Grand Canal, he took note of its ingenuity, but portrayed Chinese travelers as incurious revelers who preferred to enjoy opium in the comfort of their boats. In contrast, the European was delighted by the surrounding countryside and took the opportunity to explore. As he explored the country's mineral deposits, Richthofen envisioned networks of train tracks, development and modern amenities. For Richthofen, who tried to no avail to get the Qing government to sponsor his expeditions, "the opening of the first coal mines is, in my opinion, the first step to material and spiritual change of this empire of four hundred million souls. That is how the country is opened to outsiders; they will quickly expand the working of the mines and introduce European industries, build railroads and telegraphs and open China to world trade and civilization."<sup>15</sup>

The 19<sup>th</sup> century was the great age both of the railroad and exploration. And often both went hand in hand. In his work, Richthofen frequently cited the American geologist Raphael Pumpelly, who had surveyed some coalfields in China in the early 1860s. In 1861, the Tokugawa Japanese government had hired Pumpelly and another American engineer to examine Japanese coal works. A reactionary backlash ended many of the government's liberal schemes and in February 1863, Pumpelly's service with the Japanese government was terminated.<sup>16</sup> He then traveled to China, where the Qing government, at the time in negotiations to purchase a fleet of gunboats, engaged his services to assess some coalfields that might supply these vessels. The gunboat deal later fell through, but Pumpelly's work aided Richthofen's much more thorough studies. Coal was on everyone's agenda. Fortunately for Richthofen, he arrived in China at precisely

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<sup>15</sup> Richthofen, *Ferdinand von Richthofen's Tagebuecher aus China*. 28.

<sup>16</sup> Raphael Pumpelly, "Travels and Adventures of Raphael Pumpelly," (1920). 210-6.

the right time – after major rebellions that would have blocked his journeys, but before the major influx of foreign adventurers and profiteers; Qing state lacked the funds to sponsor his expeditions, but also the centralized control to prevent them.

In the midst of this mad European dash to lay claims to resources and land, Richthofen, like most of his contemporaries, saw little conflict between his scientific work and his duties to his homeland. Traveling by day and working by night, Richthofen also found time to send reports to Prussia with suggestions on locations for a future German port in East Asia. In December 1868, Richthofen wrote a memorandum to Bismarck with suggestions for a German maritime station on the island of Zhousan, near Shanghai.<sup>17</sup> His lengthy travels in Shandong convinced Richthofen that the province contained extensive mineral resources, ideal for a German colony. In 1897, when Germany finally acquired the Jiaozhou leasehold in Shandong, Richthofen immediately excerpted and published sections of his travel diary on Shandong in a book titled *Schantung und seine Eingangspforte Kiaotschou* (Shandong and its entrance gate Jiaozhou). In the preface to the book, Richthofen expressed great joy that his dream of a German harbor, the endpoint of a railway network and the natural entrance gate to northeastern China, had finally been realized.<sup>18</sup> Richthofen's strong involvement in Germany's acquisition of Jiaozhou led to his appellation as the founding father of the leasehold.

Yet, even as Richthofen propounded plans of economic development for China, his prose betrayed his status as a “western” explorer. He was foremost a Prussian who

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<sup>17</sup> Stoecker, *Deutschland und China im 19. Jahrhundert: das Eindringen des deutschen Kapitalismus*. 71.

<sup>18</sup> Richthofen, *Schantung und seine eingangspforte Kiautschou*. XII.

grew up in the era before German unification and rapid industrialization. At the time of his arrival in China, Germany, too, was undergoing great change. At one point in his journals, Richthofen wrote with a sense of amazement over the uniformity of apothecaries in China. In stores across the vast land, these kinds of stores carried the same exotic jars of herbs and extracts, and the owners assured him in each locale, all charged the same prices. A small wonder, perhaps, but Richthofen's reaction is easy to understand given the fragmented nature of mid-19<sup>th</sup> century Germany. In August of 1870, when news of the Franco-Prussian War reached Richthofen by letter from his parents, he returned to Beijing to wait for further reports with a great sense of trepidation and debated an immediate return to his homeland.<sup>19</sup> Only half way through Richthofen's expeditions did Germany finally stagger into the first ranks of European powers. As he mapped the geology of one empire, another one, his own homeland, came into being.

In the 1920s the China Geological Survey would find that Richthofen's efforts saved them years of work. His influence, however, likely also distorted the narrative of Chinese geology. When he did his research, Richthofen acknowledged his complete lack of both Chinese language skills and any interest to pursue Chinese materials. Moreover, he seemed also wholly unaware of the translation projects then proceeding in the treaty ports. On the other hand, for a number of prescient Chinese officials, the combination of Richthofen's reports, the translation projects in the treaty ports, and the increasing Western threat to Chinese defense all pointed to an urgent need to develop Chinese mineral and metal resources.

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<sup>19</sup> Ibid. V. I. 587.

While Protestant missionaries translated Western texts on geology into Chinese in the treaty ports, mineral surveying proceeded in the provinces as part of local efforts to industrialize, build railroads, modern arsenals, and ironworks. When the official Geological Surveys of China began in 1919, they focused mainly on the assessment of coalfields, but surveying and related activities date to earlier in the 19<sup>th</sup> century. A coal mine opened in Zhili in 1877 to supply fuel for the new arsenals and steamship line; “transportation of the coal from the pithead to a suitable port led to the construction of China’s first railroad. A gold mine was opened in Manchuria in the Amur River region in 1887 which was intended to help pay for Li Hung-chang’s Westernization projects.”<sup>20</sup> Beginning in 1889, Huguang Governor-General Zhang Zhidong sent out exploratory teams to assess the coal potential in Hunan, Hubei, Shanxi, and other provinces.<sup>21</sup> His interest in coal stemmed from his desire to build industry and the need for coal to supply his ironworks and arsenal projects.<sup>22</sup> In 1898, Zhang Zhidong and his merchant collaborator Sheng Xuanhai took control of Pingxiang coal mines in Jiangxi. According to Hornibrook, “Mechanical power replaced human labor, as Western drills and explosives extracted coal from the walls of the vertical mines, and electric winches hauled it out of the pits. In 1904, two horizontal adits went into operation, equipped with German-built electric trains to haul out the coal....after purification, it [the coal] was

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<sup>20</sup> Albert Feuerwerker, *China's Early Industrialization: Sheng Hsuan-Huai (1844-1916) and Mandarin Enterprise* (Cambridge, MA, 1958). 2.

<sup>21</sup> 蘇雲峰, *中國現代化的區域研究: 湖北省, 1860 - 1916*, vol. 41, *中國現代化的區域研究* (臺北, 1981). 343.

<sup>22</sup> The story emerges in the following accounts. Feuerwerker, *China's Early Industrialization: Sheng Hsuan-Huai (1844-1916) and Mandarin Enterprise*. Jeff Hornibrook, "Local Elites and Mechanized Mining in China: The Case of the Wen Lineage in Pingxiang County, Jiangxi," *Modern China* 27 (April, 2001, 2001).

coked in one of about three hundred new German coking ovens.”<sup>23</sup> For these new projects, teams of foreign and Chinese experts surveyed coalfields and analyzed the quality of extracted minerals. These experts played an essential role. For example, faulty testing by English chemists hired to test the coal quality in Hubei, in addition to slipshod management, may have contributed to the failure of two mines in the province.<sup>24</sup>

From the British and the Opium War, Richthofen’s expeditions, to Zhang Zhidong and Li Hongzhong’s sponsorship of mines and arsenals, imperialism and science in this narrative breaks from a binary of the West and China. Instead, the exploitation of natural resources to build railroads and factories and to fuel industrialization emerges as an international concern. Richthofen’s observation that the opening of mines leads to material and spiritual transformation of a society holds true in Germany as well as China. Across Europe and the world, geological surveys in the 19<sup>th</sup> and 20<sup>th</sup> centuries signaled the looming importance of fossil fuels for modernization.

A bigger question begs to be asked. What happened when European science and technology arrived in civilizations with their own indigenous solutions to concerns that differed from the European tradition? Many historians have attempted to answer the question in its various forms, while works in other fields, such as economic and sociological studies of the industrial revolution, have contributed to a fuller picture of how societies adapted to new concepts of science and technological applications. The case of geology in China, however, suggests that perhaps the model of science transmission from the West to China needs to open up the definition of science and

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<sup>23</sup> Hornibrook, "Local Elites and Mechanized Mining in China: The Case of the Wen Lineage in Pingxiang County, Jiangxi." 222-223.

<sup>24</sup> 蘇雲峰, *中國現代化的區域研究: 湖北省, 1860 - 1916*. 350.

examine more carefully the forming of new disciplines of science in the 19<sup>th</sup> century, and how these disciplines then were adapted and adopted by other cultures. Controversies and debates in geology reveal major differences within Western science, between British, American, and continental schools of thought. From another perspective, China, Germany, and Britain shared in common the driving forces of modernity – the need to industrialize, to build railroads and telegraphs, and to classify and quantify the mineral fuels for these new projects.