

Varia

The Origins of Modern Geology in China:

The Work of D. J. Macgowan and R. Pumpelly

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ABSTRACT: This paper aims to investigate the origins of modern geology in China. Although modern Western geology was introduced to China in the middle of the nineteenth century, this does not necessarily indicate that geology was literally “imported” into China. Due to pride in China’s cultural and historical traditions, translators often influenced or altered their interpretations of geological theory from the West. Moreover, nationalistic inclinations among contemporary Chinese intellectuals inevitably influenced geological research concerning Chinese territory. Considering these circumstances, herein the contributions of two Americans, D. J. Macgowan and R. Pumpelly, are examined. The former was a co-translator of Lyell’s *Elements of Geology* into Chinese, while the latter conducted the first geological surveys in China. Although they are not as well known as the Chinese geologists who founded “Chinese Geology” in the early twentieth century, they should be credited as the disseminators of modern geology in and on China. Some of their achievements, which were realized with help of Chinese intellectuals, were inherited by Chinese geologists of subsequent generations. Historical analyses of their works should shed light on the diversity of “Chinese Geology”.

KEYWORDS: Chinese Geology, D. J. Macgowan, R. Pumpelly, Jiangnan Arsenal, *Yangwu* or self-strengthening Movement

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1. Introduction

On January 1, 1912, Sun Yat-sen (孫中山 or 孫文: 1866–1925) was inaugurated as the Provisional President of the newly established Republic of China, the first ever republic in Asia. Ever since the Provisional Government in Nanjing placed the Geological Section (地質科) under the Department of Mines in the Ministry of Industry (實業部礦務司) as an attempt to promote geological affairs, the progress of modern geology in China has been synchronized with its national history. This is the reason why Zhang Hongzhao (章鴻釗: 1877–1951), the first director of the section, compared their Republic: *Minguo* (民國) and Geology: *Dizhi* (地質) to twin brothers in China¹.

However, establishing a governmental section was insufficient to guarantee the proper social status for the discipline. In fact, the footsteps of geology in China were affected by shortages of financial and human resources. In addition to the long-standing political uncertainty, the history of geology in China tends to be viewed as part of the national history in a series of challenges against the difficulties of the nation. Because geology is a fieldwork-based science that aims to recognize the particularities of the land, it is easily associated with nationalistic notions. Although this tendency is also true for other nations, it appeared relatively salient in China. Since the mid-19th century the international community has viewed China as backwards in civilization, and foreign geologists consequently felt that they should launch into China to develop its natural resources because China could not study and survey its own territory. As Shen accurately pointed out, “Geology was central to both the survival of the Republic and its status as a Chinese nation”². Thus, it was quite natural that Chinese geologists were expected to play certain nationalistic roles to secure Chinese sovereignty.

On the other hand, geology itself originated as a modern science subject, which is characterized by its universality. Consequently, only after meeting the global standards could modern geology in China be considered a branch of universal academic activities. Under these circumstances, the founders of “Chinese Geology”, while admitting the exogenous nature of their discipline, strived to establish themselves in the international academic field. Although their final goal was acknowledgment of their essential uniqueness in the international context, Chinese geologists understood that they should first represent themselves as civilized scholars seeking universal truths. Needless to say, modern Western science, which

¹ Zhang Hongzhao (章鴻釗), “Zhongguo gudai zhi dizhi sixiang ji jinshinianlai dizhi diaocha shiye zhi jingguo” 《中國古代之地質思想及近十年來地質調查事業之經過》 (Geological Ideas of Ancient China and the Developments of Geological Surveys in the Last Decade), *Dixueazhi* 《地學雜誌》 (*The Geographical Journal*), vol. 13, second period (no. 144, 1922). Chinese *Dixueazhi* was founded in February 1910 in Tianjin.

² Shen, Grace Yen, *Unearthing the Nation: Modern Geology and Nationalism in Republican China*, Chicago and London: The University Chicago Press, 2014, p. 79.

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boasted that it provided universal knowledge, was incorporated into “Chinese Geology” as an inseparable component. Setting aside the oppressive nature, or imperialism, of modern Western science due to its Western-oriented ethnocentrism of knowledge, Chinese geologists longed for the recognition of their activities as being in line with the global standard.

In brief, the evolution of “Chinese Geology” cannot be sufficiently written solely within the framework of the national history of China as has been customarily done. If “Chinese Geology” grew under the interactions of complicated elements, as described above, it should have a diverse nature. From this viewpoint, the author received valuable suggestions from Shen’s work³, which revealed the various strategic activities of Chinese geologists in Republican China. She successfully analyzed how models of science and the nation converged in geological activities, focusing on the notion of “land” as the key link between loyalty to China and the authority of geology. However, an investigation of how “Chinese Geology” was initiated when the notion of “land” was still immature in China seems to be lacking. As Shen argues, modern geology was first introduced to China by foreigners but failed to attract growing interest during the last days of Qing dynasty. Nevertheless, it does not mean the Western-born geology was thoroughly replaced by “Chinese Geology” in the Republic era. Later generations should start with showing original features of “an entirely new scientific discipline of geology”⁴ which consequently have been assimilated into “Chinese Geology”. This paper searches for the origins of modern geology in China as a first step to produce a genealogy of “Chinese Geology” with a wide historical scope.

The following chapters discuss the contributions of two Americans who made efforts to introduce Western geology into China at the dawn of her modern era, D. J. Macgowan and R. Pumpelly. Although both have been recognized as forerunners of modern geology in China, they are often considered in relation to aggressive colonialism⁵. Several biographical studies outside of China pay considerable attention to their achievements in China⁶. While

³ Shen, *Unearthing the Nation*.

⁴ Sullivan, Lawrence R. and Nancy Y. Liu, ed., *Historical Dictionary of Science and Technology in Modern China*, Rowman & Littlefield, Lanham, Maryland: 2015, p. 175.

⁵ Du Shiran et al. ed. (杜石然等編), *Zhongguo kexuejishu shigao* 《中國科學技術史稿》(修訂版) (*History of Science and Technology in China*, rev. ed.), Beijing: Peking University Press, 2012, pp. 391–392.

⁶ Yatsumimi, Toshifumi (八耳俊文), “D. J. Macgowan to Chugoku, Nippon 1843–1893” [D. J. マッゴワンと中国, 日本 1843–1893] (D. J. Macgowan and China, Japan: 1843–1893), *Yogaku* 『洋学』 (*Annals of the Society for the History of Western Learning in Japan*), The Society for the History of Western Learning in Japan, vol. 1, Tokyo: Yasaka shobo (八坂書房), 1993; Champlin, Peggy, *Raphael Pumpelly: Gentleman Geologist of the Gilded Age*, Tuscaloosa, Ala.: The University of Alabama Press, 1994; Oldroyd, David and Yang Jing-Yi, “On Being the First Western Geologist in China: The Work of Raphael Pumpelly (1837–1923),” *Annals of Science*, vol. 53, issue 2, (Mar., 1996).

this paper is partly based on previous biographical studies, its main purpose is not to survey their whole lives but to intensively examine how they developed the new field of geology in China, which later became a breeding ground for “Chinese Geology”.

2. Around *Dixueqianshi* (地學淺釋), a Chinese Translation of Lyell’s *Elements of Geology*⁷

2-1. Establishment of a Translation Bureau at the Jiangnan Arsenal in Shanghai and *Dixueqianshi*

*Dixueqianshi*⁸ is a translation of Lyell’s *Elements of Geology*, the 6th edition⁹ into traditional Chinese, and is considered the first introduction of Western geology into China. The publisher *Jiangnan Zhizaoju* (江南製造局) was a governmental arsenal established by Zeng Guofan (曾國藩) and Li Hongzhang (李鴻章) in Shanghai in 1865. Bolstered by the *Yangwu* movement (洋務運動), which aimed at self-strengthening China against Western Powers, the institute intended to introduce Western technology, establish the capability to produce steamships, guns, and powders by themselves, and train Chinese engineers. Three years later, the *Fanyi guan* (翻譯館), or Translation Bureau, was attached to the institute in order to promote the translation and publication of books on Western sciences. This was an epoch-making attempt of a governmental promotion to translate Western scientific and technical books for practical purposes under the Qing dynasty both for and by the Chinese.

Nevertheless, well-trained and experienced native Chinese translators were insufficient to publish such translations. Consequently, the method of *Xiyizhongshu* (西訳中述) was devised. In this method, a Western translator dictates a translation into colloquial Chinese, which is subsequently converted by a Chinese cooperator into the classical style of traditional written Chinese. In fact, this method had been used in China since the Jesuits missionaries of the late Ming dynasty. It is needless to say that the translated works by missionar-

⁷ As to the introduction of *Xixue* or Western sciences into China and Japan in the historical context focusing on *Dixueqianshi*, see Takegami, Mariko (武上真理子), “Kanyaku chishitsugaku-sho ni miru ‘Seigaku Tozen’—Konan Seizo-kyoku Honyakukan kan *Chigakusensyaku* wo rei toshite—” 「漢譯地質學書に見る「西學東漸」—江南製造局翻譯館刊『地學淺釋』を例として—」 (Some Aspects of Cultural Transmission from the West to the East: A Case Study of *Dixueqianshi*, a Chinese Translation of Lyell’s *Elements of Geology* by the Kiangnan Arsenal, Shanghai), in *Tôyôshi-Kenkyû*『東洋史研究』(*Journal of Oriental Researches*), vol. 73, no. 3, December 2014, written in Japanese with English abstract. Jiangnan Arsenal was expressed as Kiangnan Arsenal in the late Qing period.

⁸ *Dixueqianshi*《地學淺釋》(*An Outline of Geology*) in 38 vols, Shanghai: Jiangnan Zhizaoju (江南製造局), 1871.

⁹ Lyell, Charles, *Elements of Geology or the Ancient Changes of the Earth and its Inhabitants as Illustrated by Geological Monuments*, 6th ed., London: John Murray, 1865.

ies were expected to propagate Christianity. Both scientific books and religious ones that conformed with Christian doctrines were translated into Chinese¹⁰. However, in the case of the Jiangnan Arsenal, the Chinese directors wanted to use in-house translators unaffiliated with missionary tasks. Eventually the directors found John Fryer (傅蘭雅: 1839–1928)¹¹, originally an English missionary. He was selected due to his knowledge of Chinese first of all, but because he was not eager for his missionary task, he was prone to isolation by the foreign community in China. Although he was not trained in any scientific discipline, Fryer ambitiously contracted with the Arsenal. He undertook the task of translation as well as selecting and ordering English books about science and technology. Charles Lyell's *Elements of Geology* was included in his plentiful March 1868 order¹².

Due to Lyell's significant contribution to modern geology, he is known as the "Father of Geology". Although it is unnecessary to expatiate at length on the value of his work, it is noteworthy that the sixth edition of his *Elements of Geology* was published in 1865, one year after Lyell publicly announced a change in attitude from wary to fully supporting Darwin's Theory of Natural Selection, which admitted the possibility of an infinite variety of change of species. Since then, Lyell had been revising his works, including *Elements of Geology*, to reflect his "conversion". However, it is unlikely that Fryer, who was almost a beginner in any field of science in 1868, recognized such a detail. In addition, it is doubtful whether Fryer could understand the academic contents of the latest standard textbook of British geology after he obtained a copy. In any case, the mission of translating this book was eventually tasked to another person.

¹⁰ For more about the translated works by Protestant missionaries in the late Qing period, refer to Yoshida, Tora (吉田寅), *Chugoku Protestant Dendo-shi Kenkyu* 『中国プロテスタント伝道史研究』 (*A Study on the History of Chinese Protestant Mission in the 19th Century—Especially on Missionaries' Chinese Works*), Kyuko-shoin (汲古書院), 1997. Among the houses of translation and publication run by Protestant missionaries in the late 19th Century, *Mohai shuguan* (The London Missionary Society Press: 墨海書館) was famous for their publication of scientific books, many of which were imported into Japan, and greatly influenced "Samurai engineers." However, the original intention of translating scientific books was to reveal the universal truth that God had created.

¹¹ John Fryer was from Hythe, Kent, Southeast of England. Arrived in China in 1861. Taught in St. Paul's College, Hongkong and Tonwen Guan in Beijing (北京同文館), or the imperial interpreters' college, before moved to Shanghai in 1865, where became the first principal of Yinghua shuguan (英華書館: C.M.S. Anglo-Chinese School). Besides the corporation for translation in Jiangnan Arsenal, promoted Western sciences in various way in China. Later moved to USA and obtained a professorship of Oriental Languages and Literature at the University of California.

¹² "To Smith Elder & Co: orders books for the Arsenal: list of 70 books," *The John Fryer Papers* 《傅蘭雅檔案》, Dagenais, Ferdinand (載吉礼) ed., vol. 1, Guilin: Guangxi Normal University, 2010, pp. 348–351.

2-2. *Dixueqianshi* as a translation

The translation of Lyell's *Elements of Geology* was realized through the cooperation of Daniel Jerome Macgowan (瑪高溫: 1815–1893)¹³ and Hua Hengfang (華衡芳: 1833–1902)¹⁴, the former as a translator into colloquial Chinese and the latter as a proofreader in classical literary Chinese. It should be noted that neither Macgowan nor Hua was an expert in geology, but each was a specialist in another field of science, medicine and mathematics, respectively. Accordingly, they were equipped with a fundamental knowledge of science in general. Furthermore, both were quite familiar with Chinese translations of Western sciences when they started translating works at the Jiangnan Arsenal; Macgowan as a publisher and Hua as an ardent reader of those kinds of books. Hence, they fully understood the importance of translating Western books of science into Chinese for practical use. Macgowan, in particular, had experience translating books on different scientific topics, such as the telegraph and navigation, and seemed to be well suited to translate a book about an unfamiliar scientific field, geology.

Prior to translating the geology book, they worked together to translate a book on mineralogy, *Jinshishibie* (金石識別)¹⁵, because mineral resources were expected to bring prosperity and power to China¹⁶. Lyell's book was then intended as an introduction of geology into China as part of a continuous effort to broaden *Jinshixue* (金石学), that is mineralogy, in general. However, the task was harder than anticipated. One of the first difficulties was finding the proper Chinese equivalents for various technical terms in geology, which was in the midst of a drastic fundamental change, as well as suitable characters for proper names of

¹³ Born in Massachusetts, of Irish origin, Macgowan visited China in 1843 as a medical missionary of the Baptists. While serving as a doctor in and around Ningbo, he published his writings as well as translations both in English and Chinese, among which *Bowutongshu* 《博物通書》 (Aihuatang [愛華堂], 1851, a text book for telegraph and electricity in general) and *Hanghaijinzhen* 《航海金針》 (Aihuatang [愛華堂], 1853, a book of navigation and meteorology) were imported in Japan at the close of Tokugawa regime and appreciated as leading guides of Western technology. He visited Japan himself for three times as well as travelled widely in Asia and Europe. He lived in Shanghai in the later part of his life and was known as one of the oldest residents there, and died in Shanghai.

¹⁴ Courtesy name Ruoting (若汀), came from Jinkui in Jiangsu (江蘇省金匱), today's Wuxi. Having loved mathematics from his childhood, Hua learned Western mathematics through the Chinese translations of Western books when he was learning in Shanghai in his youth. Later became a member of staff for Zeng Guofan and contributed *Yangwu* movement for its technological aspects, in addition to educational activities.

¹⁵ *Jinshishibie* 《金石識別》 (*Identification of Minerals*), 12 vols. Shanghai: Jiangnan Zizaoju, 1871. The original: Dana, James Dwight, *Manual of Mineralogy: including observations on mines, rocks, reduction of ores, and the applications of the science to the arts, with 260 illustrations, designed for the use of schools and colleges*, new ed., New Haven: Henry H. Peck, 1857.

¹⁶ Hua Hengfang, "Introduction", *Jinshishibie* <<金石識別>>序>.

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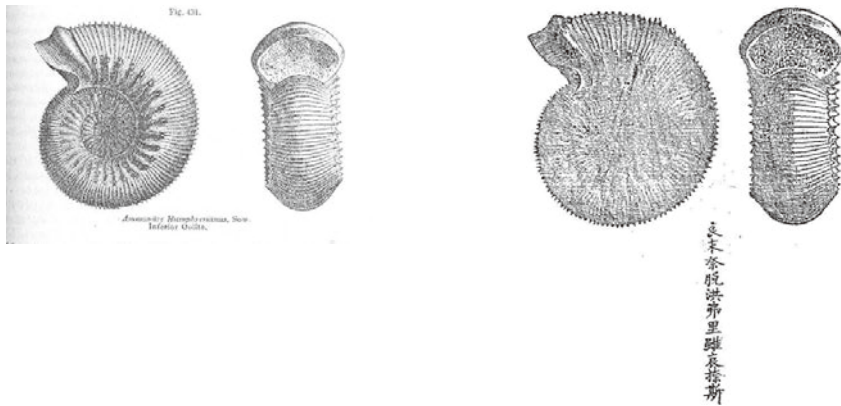


Fig. 1 Illustrations of a fossil of Ammonite (哀末奈脫)
Left: *Elements of Geology*, Ch. 20; Right: *Dixueqianshi*, 20 juan (卷)

newly discovered fossils and such. Thus, they employed the following principles:

- (1) Search for an existing equivalent.
- (2) Coin a new combination of Chinese characters that reflects the meaning of the original term.
- (3) If there is no precedent, employ phonetic transliteration for proper names, which could not be translated.

The first principle only applied to a few cases. The large majority of words were coined using the second and third principles. As a result, most of their laborious neologisms were not inherited as Chinese equivalents by later generations, as *Jiangshi* (疆石: fossil, by meaning), *Peiyuxin* (沛育新: Pliocene, by phonetic, same as below), *Maiyuxin* (埋育新: Miocene), *Yiyuxin* (瘞育新: Eocene), *Tuolaiyuesi* (脫來約斯: Triassic), *Kanbeilian* (堪忒里安: Cambrian), and *Ailifasipolaimiqiyesi* (哀里發斯潑來每奇業斯: Elephas primigenius, or Mammoth). However, this publication has historical significance; it certainly is a pioneering attempt to adopt Western science. Figure 1 is an example of a phonetic transliteration of a proper name for an ammonite shown together with a reproduction of the original plate. The novelty of this book is certain.

In addition to the challenging work of translating English terms into Chinese, there must have been further difficulties in the translation of the fundamental theory of geology. The following appears in the introductory chapter of the first volume of *Dixueqianshi*:

地之定質，為泥，為砂，為灰，為炭。其石，或嫩，或堅。此固夫人而知之者也。然不仔細察之，必以為，從古至今本是如此。惟究心地理者，知其不是忽然，而成均有逐漸推移之據。

(The basic nature of the earth is comprised of mud, sand, lime, or coal. Some minerals are feeble

while others are solid. Everyone knows this. However, it is easy to believe that these stones have been in their current form since ancient times without detailed observations. Only those inclined to scrutinize the theory of the earth would learn that there are grounds to think that the earth uniformly followed a principle of gradual succession and did not suddenly take the form it is in today. [underlined by Takegami]

The underlined sentence simply states the essential idea of geological gradualism, which is a core concept of Lyell's Uniformitarianism in geology. Although not a literal translation, it does reflect the original intent. It is worth noting that the Chinese version has a section of *Shengwujiabian* (生物漸變), or gradual changes of life, in volume 13, which clearly shows the translators' view that gradualism should be applied to the living creatures as well as geological phenomena. This is a distinctive contrast to Lyell's discreet attitude about the gradualism of life.

With regard to the gradualism of life, volume 13 contains remarks on Lamarck (勒馬克) and Darwin (兌兒平). Prof. Yatsumimi¹⁷ has already noted that these sentences in the Chinese text were originally a new footnote for the sixth edition in which Lyell stated his eventual acceptance of Darwin's Theory of Natural Selection. The Chinese text describes Lamarck's theory of progression as "not yet accepted" while Darwin's Theory of Natural Selection as "not yet established". As a consequence, we cannot correctly read Lyell's "conversion" in Chinese. This difference may be due to the fact that China did not have to consider the Christian view of Creation when discussing biological succession. In brief, Macgowan and Hua tried to introduce the fundamental concepts of modern Western geology (i.e., gradualism) while ignoring the controversies surrounding the Evolutionary theory and the Christian view of the world in the West because the main purpose of the Translation Bureau of Jiangnan Arsenal was the dissemination of practical sciences and technologies.

Ironically, *Dixueqianshi*, which was once published as a primary textbook of practical geology, is regarded as the first introduction of the Theory of Evolution to China in the successive historical context. When *Dixueqianshi* was first published, it was not adopted as a textbook at the Jiangnan Arsenal because Western instructors did not understand the Chinese language. On the contrary, in the midst of a swelling boom of Western sciences, their Chinese translations were zealously welcomed in Japan. As most Japanese intellectuals in the early Meiji period were familiar with *Kanbun* (漢文), or Chinese literature, Chinese translations of Western science and technology became widespread in Japan. *Dixueqianshi* was one of the most popular books partly because of the fame of Lyell and the importance of geology for the national industrialization. Then it was reintroduced to China after the Sino-Japanese War (1894–1895) when it was highly regarded by the leading reformation-

¹⁷ Yatsumimi, "D. J. Macgowan to Chugoku, Nippon 1843–1893," pp. 74–76.

ists, e.g. Kang Youwei (康有為) and Liang Qichao (梁啟超), who saw the progress a self-evident axiom and had faith in social Darwinism. In brief, it was the political leaders of *Bianfayundong* (變法運動) or the reform movement that considered *Dixueqianshi* as a basic text of Evolutionism.

In addition to the interpretation from the viewpoint of Evolutionism, there was another attempt to use *Dixueqianshi* as a textbook to educate engineers of mining. As an alternative to the millennium-old promoting system of *Keju* (科舉) or Imperial Examination, China adopted a new education method modeled after Japan's reformation at the end of the 19th and the beginning of the 20th century. The new educational system aimed to train engineers to achieve national *fuqiang* (富強), prosperity and power. Consequently, geology, which was inseparably combined with mining, had come to play an important role in developing the nation's natural resources and many people considered *Dixueqianshi* as a guide to the practical geology. For example, Lu Xun (魯迅: 1881–1938), who is one of the most famous literati in modern China, studied geology and mineralogy at the School of Mines and Railways of the Jiangnan Military Academy in Nanjing (南京礦路學堂). He ardently read *Dixueqianshi* and *Jinshishibie* before he came to Japan in 1902. In 1903, he wrote “Zhongguo dizhi lue lun” 〈中國地質略論〉¹⁸ for a magazine published by Chinese students in Japan, which was later revised and enlarged into *Zhongguo kuangchan zhi* 《中國礦產志》¹⁹ in collaboration with Gu Lang (顧琅: 1880–?). *Zhongguo kuangchan zhi*, which was reprinted several times in China, was evaluated as “the best book on the Mineral Wealth of China, with an atlas” by Chinese geologists in the later ages²⁰. Even though Lu Xun wrote about Chinese geology under the direct influence of Japanese geology during his stay in Japan, it should be noted that he had previously studied the basic elements of geology with *Dixueqianshi*.

As already stated, most of neologisms that appeared in *Dixueqianshi* were not inherited by later generations. This is mainly because they were replaced by “Wasei-kango” (和製漢語), which are Chinese words that Japanese scholars coined when translating Western

¹⁸ Suozi (索子: another pen name for Lu Xun), “Zhongguo dizhi lue lun” 〈中國地質略論〉 (A brief sketch of Chinese geology), *Zhejiang chao* 《浙江潮》, vol. 8 (Oct., 1903). As Prof. Nakajima proved, most of “Zhongguo dizhi lue lun” is a translation of Japanese article, Kimotsuki Kaneyuki (肝付兼行), “Toyo no Baigen” 「東洋之煤源」 (Coal mines in the East), *Taiyo* 『太陽』 (*The Sun*), vol. 9, no. 5 (May, 1903). Nakajima, Osafumi (中島長文), “Kirinuki-cho yori: Rojin “Chugoku chishitsu ryakuron” chizu oyobi sonota” 「——一切抜き帳より——魯迅「中國地質略論」地図及びその他」 (A discovery in my scrap book: a map and others in Lu Xun “Zhongguo dizhi lue lun”), *Hyofu* 『颯風』 vol. 34 (Dec., 1998).

¹⁹ Gu lang and Zhou Shuren (顧琅, 周樹人: Lu Xun's autonym), *Zhongguo kuangchan zhi* 《中國礦產志》 (*Topography of Chinese Mineral Resources*), Shanghai: Shanghai puji shuju (上海普及書局), 1906. This book was first published in Tokyo in 1904 and republished in Shanghai.

²⁰ Wang, Chung Yu, *Bibliography of the Mineral Wealth and Geology of China*, London: Charles Griffin & Co., 1912, p. 32.

words into Japanese. As is well known, Chinese students, including Lu Xun, not only learned them in Japan but also brought them back home. The word for fossil, *Jiangshi* (殭石), for example, was replaced by *huashi* (化石), which has a Japanese origin²¹. However, it is noteworthy that this new vocabulary was first produced in Japan and later accepted in China on the common basis of Chinese literature by which *Dixueqianshi* had been written. In brief, Macgowan's translation introduced the fundamental theory of modern geology into China, but its knowledge circulated first in Japan and then in China.

On the other hand, if we consider that the ultimate aim of Macgowan was to disseminate practical sciences and technologies, the origin of geological fieldworks as well as translation activities should be searched. The next chapter discusses the first geological survey in China, which took place a few years before the translation activities of the Jiangnan Arsenal.

3. A Genealogy of “Chinese Geology” since Pumpelly²²

3-1. Attempts at a geological survey in China

It is commonly accepted that the pioneer of geological surveys in China is Raphael Pumpelly (龐培勒 or 龐佩利: 1837–1923)²³. Although his name is long forgotten, he played an important role in the founding stage of geology in North America. His contribution may perhaps be summed up as leading a group of experts with professional knowledge of mining as well as the frontier spirit who strived to promote the natural resources of the New World.

Even among his peers, Pumpelly was distinctive due to his wide connections, which allowed him a variety of social activities and the ability to pursue his interests in the realms of humanities, including the study of history. He achieved social fame as “the gentleman geologist of the Gilded Age”²⁴ originally through his exploration survey in China. It consisted of four parts: ① a geological survey around Changjiang (長江) (May to July 1863),

²¹ As to the history of searching for an appropriate Japanese equivalent for “fossil”, see Yoshino, Masaharu (吉野政治), “*Kaseki no goshi: Toyo-shizentetsugaku to seiyo-kagaku no aida*” [「化石」の語誌——東洋自然哲学と西洋科学の間——] (The History of the Word “Kaseki”: between Oriental Natural Philosophy and Western Science), *Doshisha Joshi-daigaku Sogobunka-kenkyusho Kiyo* 『同志社女子大学総合文化研究所紀要』 (*Bulletin of Institute for Interdisciplinary Studies of Culture Doshisha Women's College of Liberal Arts*), vol. 27, March, 2010.

²² On the historical position of Pumpelly in the American geology in its founding stage as well as on his surveys and their relation to Chinese geology, see: Takegami, Mariko (武上真理子), “*Kindai-Chugoku ni okeru chishitsu-gaku no genryu—R. Pumpelly wo chushin ni*” [近代中国における地質学の源流—ラファエル・パンペリーを中心に] (In Search for the Origins of Geology in Modern China: Centering on R. Pumpelly), in *Gendai-Chugoku bunka no shinso kozo* 『現代中国文化の深層構造』 (*Deep Structure of the Modern and Contemporary Chinese Cultures*), 2015 (downloadable at <http://www.zinbun.kyoto-u.ac.jp/~rcmcc/>).

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② a survey of coal mines in the Beijing Xishan (北京西山) districts (October to November 1863), ③ a geological survey around the Great Wall (萬里長城) area (April to June 1864), and ④ a traverse exploration from the Mongolian Plateau through Siberia (November to December 1864). The last leg was more of an adventure trip.

The map in Figure 2 is newly composed by examining a “Hypothetical Map of the Structure of China”, an appendix to Pumpelly’s treatise²⁵ published by the Smithsonian Institute. The dashed lines ① to ③ roughly show the first three areas in his survey. This map clearly shows the basic geological structure of China, which Pumpelly named the “Sinian” system after the archaic name of China that runs through the Chinese continent from the northeast to the southwest. While it may be too bold to propose a hypothesis for the entire country using the limited areas he actually surveyed, the map could be regarded as the first ever scientific visualization of the geological structure of an unknown continent. As he stated in the same treatise, Pumpelly formulated his hypothesis referring to geographical information either scattered in Chinese classics or accumulated by explorers and missionaries in and out of China.

Furthermore, the width of the “Chinese Coal Measures” in this map may have been estimated mainly on the basis of his observations in the first exploration, existing information, and wishful thinking. This map should be considered a reflection of the high expectations for China’s coal resources at that time.

²³ Born in Owego, N.Y. After leaving a local school, stayed in Europe and learned at Freiberg Mining Academy, while looking around through Europe to widen his knowledge on geology and mineralogy. In 1860, worked for mines in Arizona. Next year came to Japan, together with William P. Blake (1826–1910) by an invitation from Japanese government of Tokugawa Bakufu. After conducting a survey in Hokkaido, moved to China, then got back to USA in 1865. Conducted surveys for copper and iron mines around the Lake Superior, Michigan (1866–1877), Geological Survey for the government of Missouri State (1871–1872), directed a division in the Geological Survey for the Federal Government (1879–1881), organized the Northern Transcontinental Survey (1882–1884). He was a Professor of Mining Science at Harvard University when the department was still new. One of founding members both for American Institute of Mining Engineers and Geological Society of America. The vice chairman for the conference of International Geological Society, Washington, 1891, and the president of Geological Society of America from 1905. He was also a member of National Geographic Society, American Association for the Advancement of Science, and National Academy of Science. Supported by Carnegie Foundation, carried out an exploration survey through central Asia from 1903 to 1904.

²⁴ Champlin, *Raphael Pumpelly: Gentleman Geologist of the Gilded Age*, pp. 203–215.

²⁵ Pumpelly, Raphael, *Geological Researches in China, Mongolia, and Japan, during the years 1862 to 1865*, Washington: Smithsonian Institution, accepted for publication, 1866, also appeared in Smithsonian Contributions to Knowledge, vol. 15, 1867. As to the composition of the map shown in this paper, I would like to acknowledge various helpful suggestions given by Dr. Toshihiro Yamada.

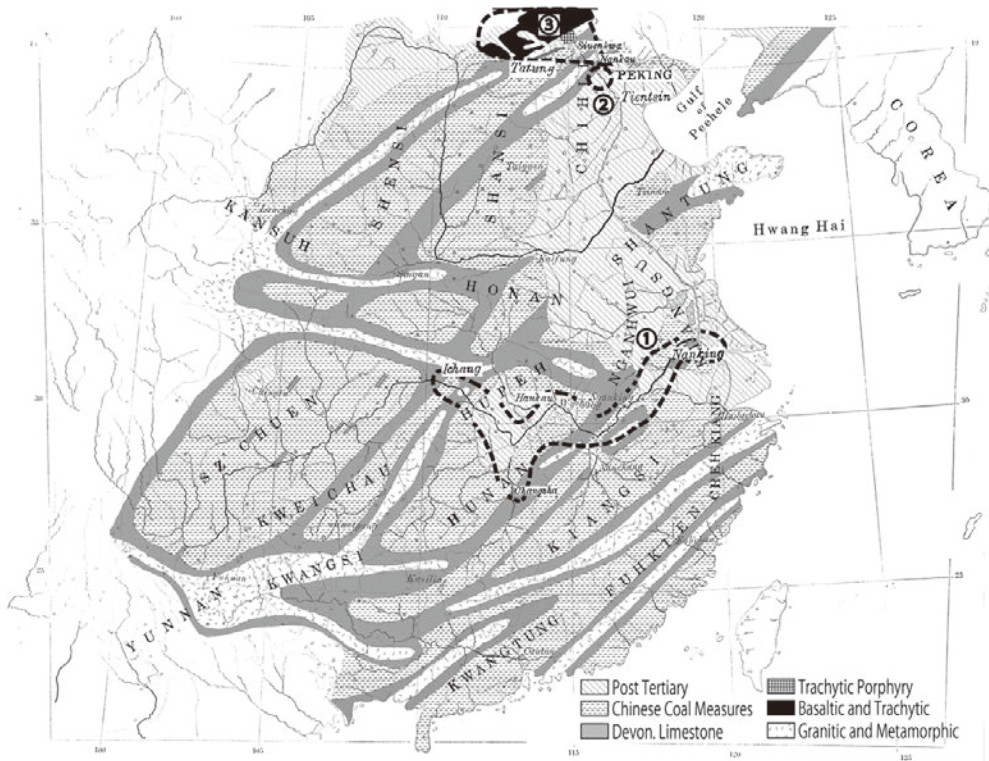


Fig. 2 “Hypothetical Map of the Structure of China”, composed from the PLATE6, in *Geological Researches in China, Mongolia, and Japan*.

In fact, the second survey of Pumpelly was an official mission commissioned by the Chinese (Qing) government with support from the ministers of the United States and United Kingdom in Beijing. The report submitted to the American Legation in Beijing was highly regarded both in the United Kingdom and France as well²⁶. On the other hand, China found very little practical use for the Chinese version of the report, which was supposedly submitted to the Qing Government, but some effects of it can be traced in the *Yangwu* or self-strengthening movement.

²⁶ Pumpelly, Raphael, “Combustibles du Se-Shan, Chine,” *Annales des Mines* 9, 1866; Knight, Sparrow and Pumpelly, Raphael, *The Coals from Se-shan, (the hills west of Peking) communicated to the ‘Friend of China’*, Shanghai, 1867.

3-2. The *Yangwu* movement and Pumpelly

When it was commissioned, the Jiangnan Arsenal was charged with four main tasks [i.e., *Kaimeiliantie* (開煤煉鐵: Developing Coal Mines and Smelting Iron), *Zizaodapao* (自造大炮: Manufacturing Guns by Ourselves), *Caolianlunchuan* (操練輪船: Driving Steam Ships), and *Fanyixishu* (翻譯西書: Translating Western Books)]. Because the development of coal mines was the highest priority, the Translation Bureau initially addressed the task of translating introductory books on coal mining and running of mines.

Kaimeiyaofa (開煤要法)²⁷ was the translation of a guidebook for mining engineers published in the United Kingdom. Although some of the contents were omitted (e.g., appendices like the glossary of technical terms for geology and the geological chronicle) or boldly abridged “*Taixishuguo chanmeijilue*” (泰西數國產煤紀略: Introduction of Coal Fields in the West), the texts of the translated parts were generally true to the original. However, it should be noted that a supplemental chapter “*Zhongguoshusheng chanmeilunlue*” (中國數省產煤論略: A Short Note for the Production of Coal in Some Chinese Provinces) was appended, presumably as a supplementary explanation for Chinese readers.

京師西山素稱產煤富有之地。今有西人前往攷察。得所見聞隨時紀錄，並寄至泰西各國互相衡較。僉曰甚佳。惟取煤各法未造精妙，恆費工多而得煤少。

(Xishan or mountains in the West of Beijing are renowned for their abundance of coal. A Westerner has recently come to observe coal mines in this area. He recorded what he saw and heard, and distributed his records among Western countries in order to have them compared with coal reserves in other countries. The all examiners admit the excellent quality of the Xishan mines. However, the practices of producing coal can be further refined, spending a large amount of expense for a small gain. [underlined by Takegami])

One could easily conjecture the shadow of Pumpelly behind “西人”, a Westerner, in the above paragraph. The submission of Pumpelly’s report to the Qing government was just a few months before the establishment of Jiangnan Arsenal.

Furthermore, the chapter of “A Short Note for the Production of Coal in Some Chinese Provinces” included an abridged translation of an article from a source other than the original book. In the periodical²⁸ where the article was originally published, another article frequently mentioned the surveys conducted by Pumpelly, strongly suggesting that the translation of

²⁷ *Kaimeiyaofa* 《開煤要法》(*Methods of Developing Coal Mines*), Shanghai: Jiangnan Zizaoju, 1871. The original: Smyth, Warrington Willinson, *A Treatise on Coal and Coal Mining*, London: Virtue Brothers, 1867. *Kaimeiyaofa* was translated into colloquial Chinese by Fryer, and refined into classical Chinese by Wang Dejun (王德均). Fryer had almost finished his part by the end of July 1868.

Kaimeiyaofa used the surveys by Pumpelly as a reference. As mentioned above, translations of books about geology in the Jiangnan Arsenal developed from mineralogy of *Jinshishibie* to modern geology of *Dixueqianshi*. The selection of these titles is consistent with the connection between Pumpelly's surveys and *Kaimeiyaofa*.

If the translating activity of the Jiangnan Arsenal was an attempt to introduce *Xixue* or Western sciences through letters, there was also an attempt to accept the latest technologies through developing human resources [i.e., the government-supported project to send students, who were called *Liumeiyoutong* (留美幼童), or youth to stay in America. More than 120 Chinese boys, most of whom were under 15 years old, crossed the Pacific Ocean between 1872 and 1875]²⁹. They were originally given the duty of mastering military management, naval management, arithmetic, and product industry, but later some were ordered to transfer to schools of higher education where students learn in the “schools of mining industry”³⁰. As a result, around ten students entered the schools of mines at Lafayette College, Columbia University, and Massachusetts Institute of Technology.

Although none of them studied personally under Pumpelly, Pumpelly was at the core of the American academic community composed of geologists and mining engineers. In fact, some teachers at the aforementioned schools of mines were Pumpelly's fellows or followers who gathered at the American Institute of Mining Engineers and the Geological Society of America. The most noteworthy point is that Pumpelly was a respected authority on Chinese geology in the United States. As the following table shows, there were very few reports on Chinese mineral resources and geology written in English before these Chinese students left the United States in 1881. Although a German geologist, Richthofen, was coming into prominence and would eventually rewrite Pumpelly's reports, his publication had yet to be completed³¹ and Pumpelly still had considerable influence. Pumpelly was renowned not only

²⁸ *Journal of the North-China Branch of the Royal Asiatic Society*, New Series No. IV (Dec., 1867). The other paper which has been translated partially therein: Rev. A. Williamson, “Notes on the productions, Chiefly Mineral of Shan-Tung”, and the article which has mentioned Pumpelly's surveys: Rev. Joseph Edkins, “The Bituminous Coal Mines west of Peking”.

²⁹ As for the history of *Liumeiyoutong*, see Rhoads, Edward J. M., *Stepping Forth into the World: The Chinese Educational Mission to the United States, 1872–81*, Hong Kong: Hong Kong University Press, 2011.

³⁰ “Fu Qu Haifeng Rong Chunfu” 《復區海峯容純甫》 (A reply from Li Hongzhang to Qu Haifeng and Rong Chunfu) on the 22 January (in lunar calendar), 1877, *Yangwuyundong* 《洋務運動》(二), Shanghai: Shanghai People's Publishing House (上海人民出版社), 1961, p. 176.

³¹ Richthofen, Ferdinand von, *China: Ergebnisse eigener Reisen und darauf gegründeter Studien*, 3 vols.-I (Berlin, 1877); II (1882–1885), consisting of pt. 3 (1882), on North China; pt. 4 (1883), on paleontology; and atlas (1885); III (1912), E. Tiessen, ed.. As its bibliography shows, vol. 2 and 3 of Richthofen's monumental work on Chinese geology were published after 1881.

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for his “strictly scientific results”³² of *Geological Researches in China, Mongolia, and Japan* published by the Smithsonian Institution, but also for his “narrative of a journey”³³ across America and Asia, which included his exploration of China³⁴. It is reasonable to suppose that these Chinese students learned about Chinese geology and mining industry through Pumpelly’s work during their stay in the United States.

Although most of these students were forced to return to China before graduating when the project was suspended in 1881, some eventually became mining engineers and developed mineral resources in China. Kuang Rongguang or Kwang Kwong Ying (鄭榮光: 1863–1964), for instance, is known for his contribution to Chinese coal mines at Kaiping (開平), Lin-Ching (臨城), and other collieries. While serving as a mining engineer for the Qing government, he drew up a geological map, a distribution map of mineral resources, and sketches

Table: Foreign Literature of Chinese Mineral Wealth and Geology Published before 1912³⁵

Language, theme \ Publication year		–1881	1882–1912	Unknown	Total
English	Coal resources	8	55	17	80
	Other minerals	3	128	26	157
	Mining/metallurgy	1	38	8	47
	Geology	23	45	11	79
Others (German, French, Russian, Italian, etc.)	Coal resources	6	52	5	63
	Other minerals	8	68	6	82
	Mining/metallurgy	3	19	6	28
	Geology	43	118	14	175
Total		95	523	93	711

³² “Literary Notices: Across America and Asia,” *London Quarterly Review*, Oct. 1870, vol. 35, no. 69, p. 244.

³³ *Ibid.*

³⁴ Pumpelly, Raphael, *Across America and Asia: Notes of a Five Years’ Journey around the World and of Residence in Arizona, Japan and China*, New York: Leypoldt & Holt, 1870. The same book was published in London as well (London: S. Low, Son and Marston, 1870), and repeatedly issued up to 5th edition.

³⁵ Produced by the author based on Wang, *Bibliography of the Mineral Wealth and Geology of China*.

of fossils based on his own survey³⁶. Kwang's survey was confined to such a small part of the Zhili Province (直隸省) that his drawings were no more than rough sketches about the regional geology. Nevertheless, he is esteemed as "the first Chinese who drew local maps of Chinese geology" in the history of Chinese geology³⁷. On top of his domestic achievements, it is remarkable that he contributed an English paper titled, "Coal Mining in North China" to the *Engineering and Mining Journal* when he was working for the Kaiping Colliery³⁸.

Wu Yangzeng or Woo Yan Tsang (吳仰曾: 1862–1939) is another example of a mining engineer originally from *Liumeioutong*. He had been studying at Columbia University when he was recalled. However, he continued to study mining at Tangshan lukuangxuetang (唐山路礦學堂: Tangshan College of Railways and Mines) and then went to England to study at the Royal School of Mines, Imperial College London, with the permission of Li Hongzhang. After graduating in 1890, he returned home and worked for the silver mines in Rehe (熱河) followed by the coal and copper mines near Nanjing and then the Kaiping mines. While serving as the chief engineer or director for the mining industry organized by the Qing government, he presented at a conference of the American Institute of Mining Engineers in 1902. Benjamin Smith Lyman (1835–1920), who was a former *Oyatoi* (hired foreign teacher) for the Meiji government of Japan, commented as a discussant of Wu's presentation "Silver-Mining and Smelting in Mongolia"³⁹ and frequently referred to the works of Pumpelly as "the pioneer of Chinese geology". Lyman's reference clearly demonstrates that Pumpelly still was one of the most important figures linking mining engineers in the United States and China.

However, the gap between the attitudes of Lyman and Wu should be noted. Lyman mentioned his expectation that "Mr. Woo's straightforward, clear paper is an earnest of much, light that may be expected before long to be thrown upon many obscure oriental and archaeological matters by Chinese trained in western science", while Wu confined himself as a practical engineer explaining silver mining in Mongolia. Undertaking an endeavor such as composing a "hypothetical map" for all of China, even upon considering the geographical and historical information in Chinese sources like Pumpelly did, might not have suited the

³⁶ Kuang Rongguang, Zhilidizhitu 〈直隸地質圖〉 (a map of geology in Zhili), *Dixueazhi*, no. 1 for the first year (1910); Zhilikuangchantu 〈直隸礦產圖〉 (a distribution map of mineral resources in Zhili), *Ibid.*, no. 2; Zhilishicengguji 〈直隸石層古蹟〉 (fossils in stone layers in Zhili), *Ibid.*, no. 4.

³⁷ Huang ji qing (黃汲清), "Lüeshu Zhongguo zaoqidizhigongzuozhong mingliediyide xianquxuezhe" 〈略述中國早期地質工作中名列第一的先驅學者〉 (a brief sketch of pioneers of geological work in China), *Zhongguo kejisiliao* 《中國科技史料》 (*China Historical Materials of Science and Technology*), vol. 9, no. 1 (1988), p. 5.

³⁸ Kwang, Kwong Yung, "Coal Mining in North China," *The Engineering and Mining Journal*, vol. 44, no. 13 (Sept. 24, 1887), pp. 220–221; no. 14 (Oct. 1, 1887), pp. 238–239.

³⁹ Lyman, Benjamin Smith, "Silver-Mining and Smelting in Mongolia. Discussion of the Paper of Mr. Y. T. Woo", *Transactions of the American Institute of Mining Engineers*, vol. 33, 1903.

self-image of a Chinese *kuangshi* (礦師) or a man of mining. If we consider the fact that many of returnees were confronted with prejudice and restrictions against the “westernized” youth when they started working as Chinese officials, it is no wonder that Wu and his peers paid more attention to the material results in the mining industry rather than the “obscure oriental and archaeological matters”. In other words, the first generation of Chinese mining engineers had no choice but to succeed in practical aspects of geology in China that Pumpelly had introduced.

4. Conclusion—The Origin of “Chinese Geology”

The Geological Society of China was founded in 1922. In his inauguration speech as the first president, Zhang Hongzhao mentioned a few geological descriptions in Chinese classical texts, which could be deemed as a declaration of the establishment of “Chinese Geology”.

One should admit that the geological applications or observations by the ancients quoted above remained fragmental and not scientific enough. While being so, they stand as evidence of the existence of geological ideas among the Chinese forefathers. This fact indeed tells us the historical origin. Today we are to graft a flower from abroad onto that basis, and to wait to see it bloom. It will have to shine brightly someday.⁴⁰

Almost all Chinese geologists of the founding generation studied abroad, some in the West, some in Japan. All strived to seek the essence of the “flower from abroad”. Unlike mining engineers from *Liumeiyoutong* who preceded them, each one selected their own course of study and career path. Needless to say, their fundamental motivation must have been based on their desire for *jiuguo* (救國) or saving of their own country. Each one strived to find the “historical origin” of “Chinese Geology” within their indigenous culture and help Western geology “bloom” as a “flower from abroad”. In this context, both Macgowan and Pumpelly should be regarded laying the foundation to graft foreign geology.

As discussed above, modern geology was expected to develop the mining industry in China. It practically commenced with Pumpelly’s geological survey, part of which was included in the translation work of *Kaimeiyaofo* at the Jiangnan Arsenal. Subsequently, it led to *Jinshishibie* and *Dixueqianshi*, both of which Macgowan translated from English into Chinese. In this course of translating works from coal mining to mineralogy and geology, we can say that Pumpelly and Macgowan are linked even though they were not personally acquainted.

⁴⁰ Original: 章鴻釗《中國古代之地質思想及近十年來地質調查事業之經過》，as for bibliography, refer to the footnote. 1.

With respect of its contribution to the advancement of the mining industry in China, it is difficult to say that *Dixueqianshi*, which is a translation of Lyell's work, played a key role when it first appeared. However, through its circulation in Japan and subsequent revival in China, it eventually became a guide to modern geology. It helped young students understand the fundamental theory of mining, and it unexpectedly became appreciated as a presentation of Evolutionary theory. On the other hand, Pumpelly wielded his influence among *Liumeiyoutong*, or youth to stay in America, some of whom later became successful mining engineers in China. Although Pumpelly did not personally instruct them, the network of American mining engineers and geologists, who regarded Pumpelly as a pioneer of Chinese geology, fostered them.

As Zhang demonstrated, the founders of "Chinese Geology" initially attached importance to Chinese classics as their historical origin, but fully understood the importance of adopting modern geology with a foreign origin into contemporary China. Wang Wenhao (翁文灏: 1889–1971), another key person in "Chinese Geology" who earned a PhD in geology from the Catholic University of Leuven in Belgium, also noted that "Geology as a science was quite unknown to the ancient Chinese. Good descriptions of many minerals and fossils are to be found in ancient Chinese literature, [...] but the constitution, structure and history of the earth were as little understood in China as in Europe." Furthermore, Wang wrote that "The first qualified geologist to visit China was PUMPELLE, an American, who made short trips in China and Mongolia"⁴¹, whereas Zhang, a graduate from the College of Science, Imperial University of Tokyo, stated that *Dixueqianshi* certainly was the first introduction of foreign geology to China⁴². Hence, it is clear that the achievements of Pumpelly and Macgowan were placed in the history of "Chinese Geology" at the germinal stage.

It was the "Fathers of Chinese Geology" such as Zhang and Wang that assumed the responsibility of achieving equality through academic exchanges with foreign geologists in order to establish their independence. These endeavors would consequently allow the Chinese people to determine their history and maintain their own land. Although the road to establish and develop the Geological Society of China was rocky, tracing the steps of "Chinese Geology" in the truest sense remains a topic to be discussed. In closing, I would like to emphasize that two Americans, Macgowan and Pumpelly, paved the way to realize "Chinese Geology".

Postscript: This paper is based on my presentation at the 58th meeting for historical studies of

⁴¹ Wang, W. H., "The Geology of China," Couling, Samuel ed., *The Encyclopaedia Sinica*, Shanghai: Kelly and Walsh, 1917, pp. 201–202.

⁴² Zhang Hongzhao (章鴻釗), *Zhongguo dizhixue fazhan xiao shi* 《中國地質學發展小史》 (*A Short History of Chinese Geology*), Shanghai: Shangwu Yinshuguan (商務印書館), 1937, p. 11.

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geosciences (*Chigaku-shi Kenkyu kai*) on March 29, 2015 at Waseda Hoshi-en. The abstract was published in Japanese in JAHIGEO Bulletin, No. 44 (May 2015). I would like to thank the participants for all the helpful comments. My research is supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (KAKENHI, research project number: 26370758).