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The Impact of Travels on Scientific Knowledge: William Thomas Blanford, Henry Francis Blanford, and the Geological Survey of India, 1851-1889

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In his journal (1868, published 1870) of travels in Abyssinia with the Napier Expedition, William Blanford, on detached duty from the Geological Survey of India, wrote, "It is to be regretted that all those geologists who disbelieve in the power of running water, and appeal to such *Dei ex machina* as marine action and waves of translation, cannot see a few such marks of the handiwork of rain and rivers as are shown in these gorges." Blanford, trained in Henry de la Beche's School of Mines, was one of several English, Irish and Czech geologists who joined the newly established Geological Survey of India in the 1850s. In their travels within the subcontinent and as members of expeditions to neighboring countries, these geologists observed geological and geomorphological features unknown or unappreciated in Britain, Ireland, and the "Continent." For instance, because of experiences in India and travels in Baluchistan, Iran, Aden and Abyssinia, Blanford, like his fellow geologists, Henry Medlicott, Henry Blanford (his brother), Thomas Oldham, and Ferdinand Stoliczka. challenged conventional European positions, even, indirectly, Lyellian uniformitarianism. Travel beyond the borders of the temperate northern hemisphere played a key role in the reeducation of these geologists and in the emergence of new paradigms relating to Permian glaciation in the tropics, non-contemporaneity of similar paleofloras in Europe and Southeast Asia, terrestrial rather than marine origin of flood basalts, rivers in tropical and arid regions as agents of deep erosion, and a Permo-Carboniferous link of India, Australia and southern Africa. And Blanford, in particular, argued that earth history profoundly affects patterns of distribution of animals and plants, thus challenging the notion of determinate zoogeographic realms posited by A.R. Wallace and earlier by P.L. Sclater. Quickly assimilated into European geological literature largely through the works of Eduard Suess, to whom most of the laurels accrued, GSI geologists did not leave theorizing to their stay-at-home European colleagues. Contrary to some who argue that colonizers viewed their role primarily as field researchers and collectors of specimens, these scientists did much of the theoretical work themselves.

British and Continental geologists in the early and mid-19th century often held widely divergent views on mountain building, glaciation, long-range correlations, and volcanism. Indeed, and contrary to popular thought, not all were converts to the Lyellian uniformitarian view of the world, even among British geologists. Among those who dissented was Henry de la Beche, Director of the Geological Survey of the United Kingdom. Thus, we must take note that most of the earliest appointees to the Geological Survey of India, namely Thomas Oldham, the Medlicott brothers, and the Blanford brothers, either had been in the employ of Henry de la Beche's (Fig. 1) Geological Survey of Britain or had attended de la Beche's Royal School of Mines. Furthermore, when the Blanfords were students at the Royal School of Mines, among those who gave lectures there were Andrew Ramsey (Fig. 2) and Edward Forbes (Fig. 3), both enthusiastic supporters of Louis Agassiz's (Fig. 4) views on glaciers, de la Beche himself, and near the end of their terms, Thomas Huxley (Fig. 5), an early proponent of land bridges, a matter to which we shall return to later.

In December of 1850, Thomas Oldham (Fig. 6) was employed by the East India Company and government in Calcutta to head the newly established Geological Survey of India. Motivation for the survey was largely economic, to locate and develop mineral and related resources. Most urgently needed were coal and iron ore, the latter for the manufacture of rails for the rapidly expanding railroads, the former to meet the needs of steam-driven vessels plying the inland waterways as well as the railroads themselves. Since 1846, Oldham had been "Local Director" of the Geological Survey of Ireland, a branch of Geological Survey of the United Kingdom (Davies 1995) and Professor of Geology in Dublin (Fermor 1951a). One can only suppose that de la Beche had a hand in the selection of Oldham, as he had six years earlier when D.H. Williams was employed to survey Indian coal fields (Williams died of "jungle fever" on 25 November 1848). As an aside, the post in India carried with it a three-fold increase in Oldham's annual salary, from £300 to £1000 per annum, an additional nice incentive and one that was followed quickly by Oldham's marriage.

On his arrival in India (4 March 1851), Oldham found a minimum staff of two, both clerical, and no cadre of field geologists (Arnold 2000:25). Thus, he set about building both staff and program from ground up. His first act was to invite his general assistant in the Irish Survey, Joseph Medlicott (Fig. 7), to come to India. He also enlisted William Theobald (Fig. 8), who was then with the Geological Survey of the Punjab. Within five years, he induced Medlicott's brother, Henry (Fig. 9), and the Blanford brothers, William (Fig. 10) and Henry (Fig. 11), to join his staff, which, by the early 1860s, expanded to nine (Fig. 12) and finally 16 trained field geologists (Fig. 13). Oldham outlined a broad program for field studies and geological mapping of the vast subcontinent starting with areas in eastern India, Talchir in Orissa and Raniganj in Bengal, in which coal was known or reported to be present. Apart from good pay but oft-times abominable working conditions, Oldham allowed his staff a great range of freedom in their work, for example allowing occasional extended leaves of absence to accompany surveying and military expeditionary forces beyond the borders of administrative India.

Mapping was always considered an important program in India, as evidenced by the Great Trigonometric Survey, and as noted by Edney in "Mapping an Empire," for good reasons: (1) that of utility, that is for governance, including military, taxation, road development, and judicial purposes, and (2) economic exploitation (Edney 1997). Edney also observed that in India mapping of certain resources, notably iron, copper and other mineral deposits had been delayed because it was believed that "working of these metals might injuriously affect important articles of British import." (Edney 1997:296). Thus, it fell to the newly established survey to make up for past deficiencies. Oldham quickly added the geological and stratigraphical components to the already well-established geographical mapping program because he recognized their utility for economic development of resources.

Travel was encouraged, in part for administrative reasons, because both the East India Company and the Viceroy were called on by London for information on neighboring countries, their economically useful resources, i.e., mineral and plant products, local peoples and their governance, and partly to support the several commissions sent to survey and establish boundaries where none existed or were ill-defined. Thus, Oldham piggybacked solid geological exploration onto the agenda of economic geology and military and political expeditions, for instance (Fig. 15)

FIGURES 1–9. (1) Henry de la Beche; (2) Andrew Ramsey; (3) Edward Forbes, (4) Louis Agassiz; (5) Thomas Huxley; (6) Thomas Oldham; (7) Joseph G. Medlicott; (8) William Theobald (only known image; extracted from group image of Survey personnel 1865 [see fig. 14]); (9) Henry Benedict Medlicott.

FIGURES 10–12. (10) William Thomas Blanford; (11) Henry Francis Blanford; (12) Ferdinand Stoliczka.

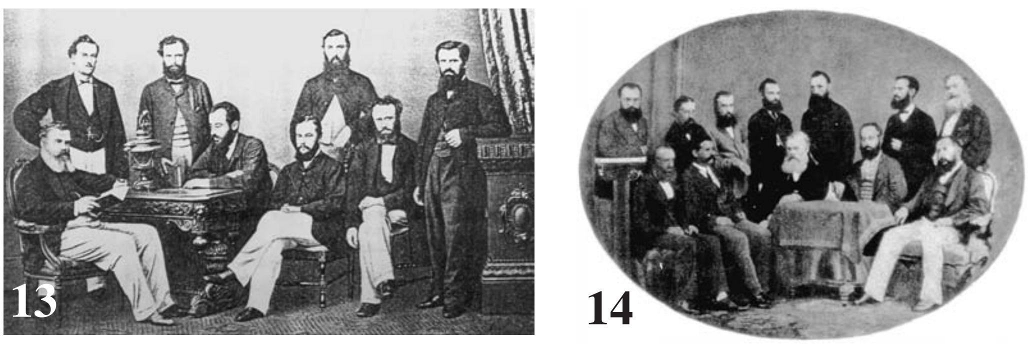


FIGURE 13–14. (13) Geological Survey of India staff, ca. 1866 (Standing, left to right: M. Ormsby, W. Blanford, C. Hacket, F. Fedden; Sitting: T. Oldham, H. Medlicott, V. Ball); (14) Geological Survey of India, ca. 1872 (Standing, left to right: F. Stoliczka, R.B. Foote, W. Theobald, F.R. Mallet, V. Ball, W. Waagen, W.L. Wilson; Sitting: A. Tween, W. King, T. Oldham, H.B. Medlicott, C.A. Hacket).

Burma for oil and gem minerals by Oldham in 1855 and 1856, and for minerals and petroleum by Theobald (1867 and 1871–1873); Aden, by W. Blanford (1867) and Mallet (1871); Andaman Islands by Oldham (1885); Tarim Basin, Turkestan, and Tibet by Stoliczka (1865–1866, 1874–1875); Nepal by Medlicott (1875); Afghanistan (the Afghan Boundary Survey) by Griesbach (1881, 1887), and others (see Fig. 15).

Early on Oldham also established a publications program as an outlet for papers on Indian geology, thereby providing timely output and rapid dissemination of survey results: the *Memoirs* (1856), *Annual Reports* (which first appeared in 1859 but later, in 1868, were published in the *Records*), *Palaeontologica Indica* (1861), and the *Records* (1868). Oldham not only gave unstinting credit to his subordinates in his annual reports, but he encouraged his staff to publish papers under their own signatures, and did not discourage speculative interpretations.

Earliest Experiences in India: A Training Ground

No sooner had they set foot in Calcutta, than the Blanford brothers, William (Fig. 10) and Henry (Fig. 11), and Henry Medlicott (Fig. 9) were assigned to work out the geology of the then little-known Talchir coal beds in eastern India (1855–1856). Their early discovery of silt and boul-

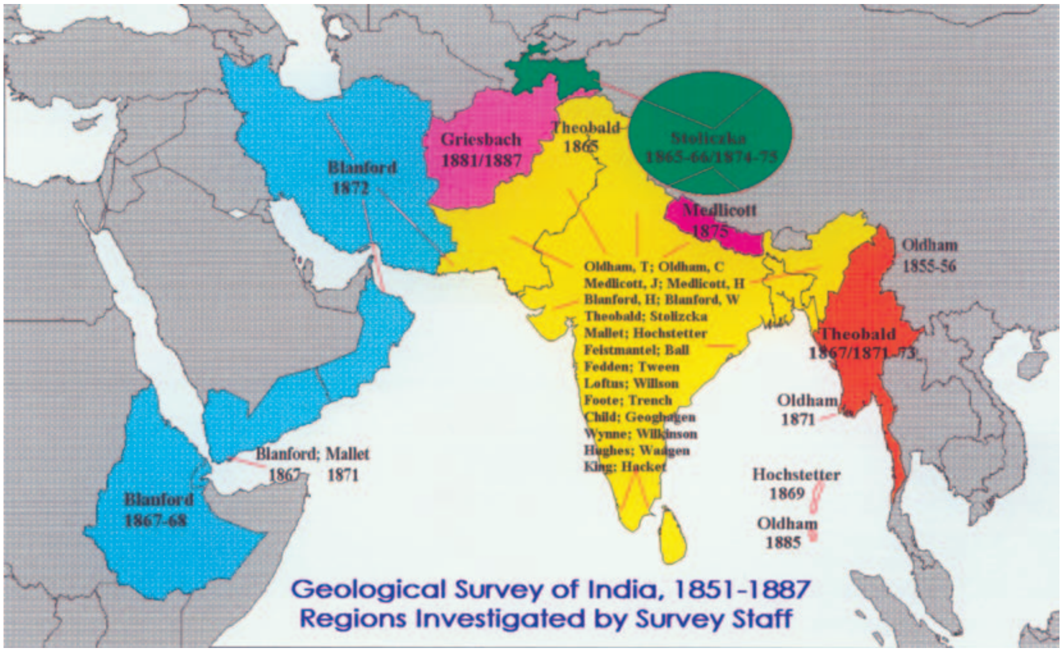


FIGURE 15. Areas investigated by staff geologists of the Geological Survey of India during the directorships of Thomas Oldham and Henry Medlicott.

ders in Permian beds overlying the coal seams, which they posited as of glacial origin, and their paleobotanical finds, led Oldham, Henry Medlicott, and the Blanfords to establish the Damuda (later the Gondwana) Series, with both Lower and Upper members. The Blanfords and Medlicott dated the lower Gondwana series as Permo-Carboniferous and William Blanford suggested that it correlated with the Newcastle formation of Australia and a similar series in South Africa (W. Blanford 1876a:83–84) and posited an "Indo-Oceanic" landmass stretching from India to Australia. Three years earlier, Henry Blanford (1873) had suggested a land connection must have existed between India and the Seychelles and South Africa based on faunal similarities that "pointed to a common origin" (H. Blanford 1873:119), and he observed that "Certain animals, whose remains are found fossil in the Panchét rocks, are closely related to kinds hitherto only met with in South Africa and Australia, in rocks of about the same age . . ." (H. Blanford 1873:119). Also, as noted by Thenius (1981:56), not long afterward, Henry Blanford posited "The affinities between the fossils both animals and plants, of the Beaufort group of Africa and those of the Indian Panchéts and Kámthis are such as to suggest

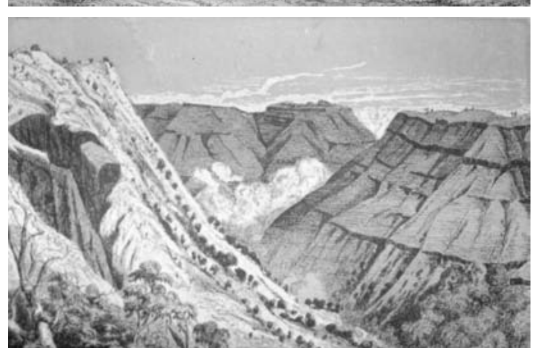


FIGURE 16 (above). Narburda Valley.
FIGURE 17 (below) Deccan and Malwa trap rocks

the former existence of a land connexion between the two areas." (H. Blanford 1875:534.) Henry's brother William also took issue with the dating of the plant fossils by Ottokar (also Otakar) Feistmantel, the paleobotanist employed by the Survey in 1875 to replace paleontologist Ferdinand Stoliczka (Fig. 12), who died on the return trip from Yarkand, in the Takla Makan/Tarim Basin, a year earlier. This led to sharp exchanges with Feistmantel (W. Blanford 1878). The squabble came about because Feistmantel thought the Lower Gondwanan flora equivalent in age to the European Triassic (notably Feistmantel 1876 [cited in 1876–1882 series], 1877), whereas Blanford, having correlated the flora with the Newcastle sequence of Asutralia, whose date as Permo-Carboniferous could be established on the basis of intercalated fossil-bearing marine sediments, argued for a Permian age (see also Feistmantel in a series of papers published in *Palaeontologica India* of the *Memoirs of the Geological Survey of India*, between 1877 and 1890) (but see also Oldham and Morris 1863, for an earlier discussion of the fossil plants of the Rajmahal Series).

Other Indian experiences that set the stage for conceptual breakthroughs included William Blanford's assignments in arid western India, notably the Narburda Valley (Fig. 16), which included the Deccan and Malwa traps (Fig. 17), which he showed were subaerial and not of marine origin and at least of upper Cretaceous age (W. Blanford 1869:9, 13 ff; 1872:83–101), and Henry Blanford's and Stoliczka's work on the Cretaceous fauna of southern India (H. Blanford 1861; Stoliczka 1865–1873).

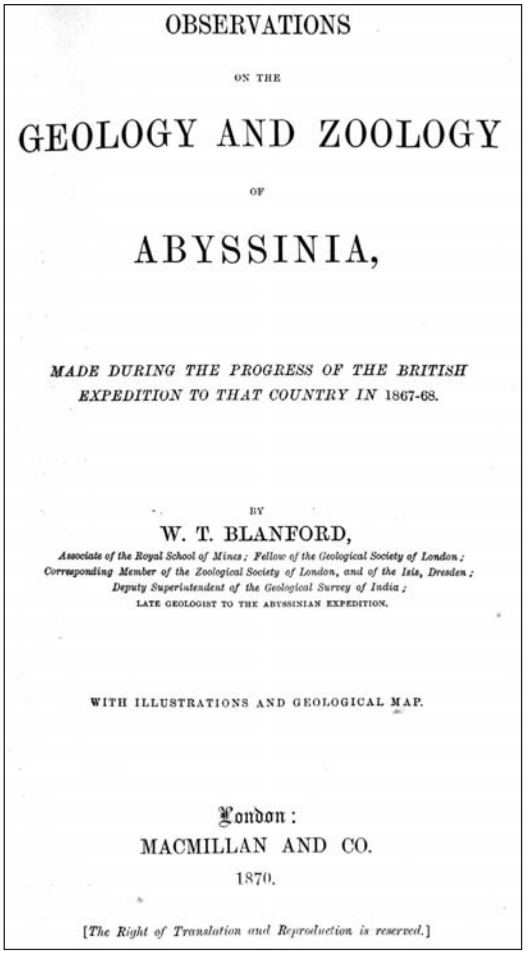
Travels in Abyssinia and Persia

In 1867, William Blanford was commissioned to serve as naturalist and geologist with the Abyssinian expeditionary force commanded by Gen. Robert Napier, assigned to relieve Europeans imprisoned by the Emperor Theodore in Magdala (just east of Lake Tana). He returned to India in September 1868 and set about writing a report on the observations and collections he had made. The report (Fig. 18), published in 1870, includes a geologic map (Fig. 19) and sections dealing with descriptive geology (pp. 143–203) and zoology (pp. 207–407). It was at this time Blanford made the acquaintance of then Lieutenant Oliver St. John, Royal Engineers, who was responsible for maintaining the telegraphic communication links for Napier's expeditionary force. St. Johns had a penchant for natural history and presented Blanford with several bird skins he had collected (Blanford *Abyssinia*:67)

Among Blanford's observations were volcanic flows in northern Abyssinia that were so much like those that he had seen in Aden, by reason of lithology and stratigraphic position, that he thought them to be part of the same event (W. Blanford *Abyssinia*:190). Indeed, if anything stands out about William Blanford's work in India, in Abyssinia, and in Persia, it is his keen sense of stratigraphic relationships, from his earliest work in the Talchir coal fields, to his use of fossil plants and mollusks in correlation of Permo-Carboniferous and Mesozoic rocks across India and his and his brother's early (1873) theoretical construct of intercontinental relationships.

Blanford lamented that he was unable to do more extensive reconnaissance, but Napier's orders did not allow time for it (W. Blanford *Abyssinia*:91). Nonetheless, Blanford made good use of the field work he was able to do. He was especially taken by what he believed to be the direct result of water as an agent in erosion (Fig. 20) and chastised European geologists who based their theories on temperate rainfall patterns, posting a challenge to the extremist interpretation of Lyellian uniformitarianism for not allowing for rapid rates of change, especially erosion by fresh water. Blanford observes,

> It is to be regretted that all those geologists who disbelieve in the power of running water, and appeal to such *Dei ex machinâ* as marine action and waves of translation, cannot see



OBSERVATIONS

ON THE

GEOLOGY AND ZOOLOGY

OF

ABYSSINIA,

MADE DURING THE PROGRESS OF THE BRITISH EXPEDITION TO THAT COUNTRY IN 1867-68.

BY

W. T. BLANFORD,

Associate of the Royal School of Mines; Fellow of the Geological Society of London; Corresponding Member of the Zoological Society of London, and of the Isis, Dresden; Deputy Superintendent of the Geological Survey of India;
LATE GEOLOGIST TO THE ABYSSINIAN EXPEDITION.

WITH ILLUSTRATIONS AND GEOLOGICAL MAP.

London:
MACMILLAN AND CO.
1870.

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FIGURES 18 (above). Title page of W. Blanford's *Abyssinia* report (1870)

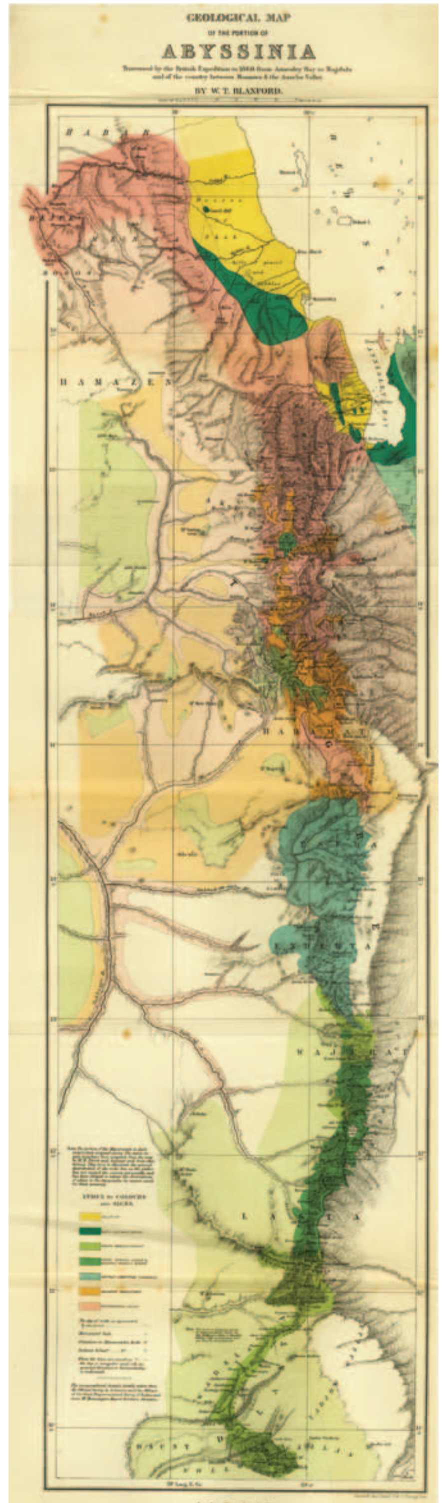


FIGURE 19 (right). Geological map drawn by W. Blanford to accompany his *Abyssinia* report.

FIGURE 20. "View of the Hamas Valley, west of Senafé. Hasheyat Hill (columnar trachyte) in the distance. The terrace on the opposite side of the valley is sandstone, while the bottom of the valley lies on metamorphic rocks. (From a Photograph by Dr. Cook.)" (W. Blanford, *Abyssinia*: pl. 2.)

FIGURE 21. "View of the Amba, or Hill-Fort of Duga, and of the neighboring mountains taken from the British camping-ground at Belago. To illustrate the mountain forms assumed by the trap rocks. (W. Blanford, *Abyssinia*: Frontispiece.)

a few such marks of the handiwork of rain and rivers as are shown in these gorges. There is not the slightest possibility, so far as I can see, of explaining their origin by any other force than that of the streams flowing in them. Any faulting or dislocation of rocks is out of the question, there is no evidence of glacial action at any past time, and even the most fervent apostle of marine denudation would scarcely credit it with the formation of a Titanic trench three-quarters of a mile deep and very little more in breadth. (W. Blanford *Abyssinia*: 87.)

A little later he added

[in the] British islands the average rainfall is about twenty-four inches distributed over the greater portion of the year. In India it averages over the whole country about fifty inches, by far the greater portion of which falls in three months . . . The effect of a river in full flood in sweeping detritus down into the sea compared with the usual denudation action, is as the comparison of the effect produced by the breakers of the ocean in a storm to those of an inland sea on an ordinarily fair day. In flood, a river is liquid mud rather than water . . . .(W. Blanford *Abyssinia*:157[fn].)

He continued,

Some years ago, . . ., I remember being struck by

> the absence of all signs of marine action and by the unmistakable evidence of immense fresh-water de-nudation in the Himalayas of Sikkim, where ravines from 6,000 to 15,000 feet in depth are evidently ex-cavations of the rivers running in them . . . so I am no new convert to a belief in the complete efficacy of rain and rivers to produce gigantic effects. But after seeing, both in India and Abyssinia, what the effects of these agents are in tropical countries, I do not feel surprised that their powers should be recognized with difficulty in regions where their effects are comparatively so dwarfed as in the British isles, while the power of marine denudation is at its maximum from the enormous coast line exposed . . . (W. Blanford *Abyssinia*: 158[fn]).

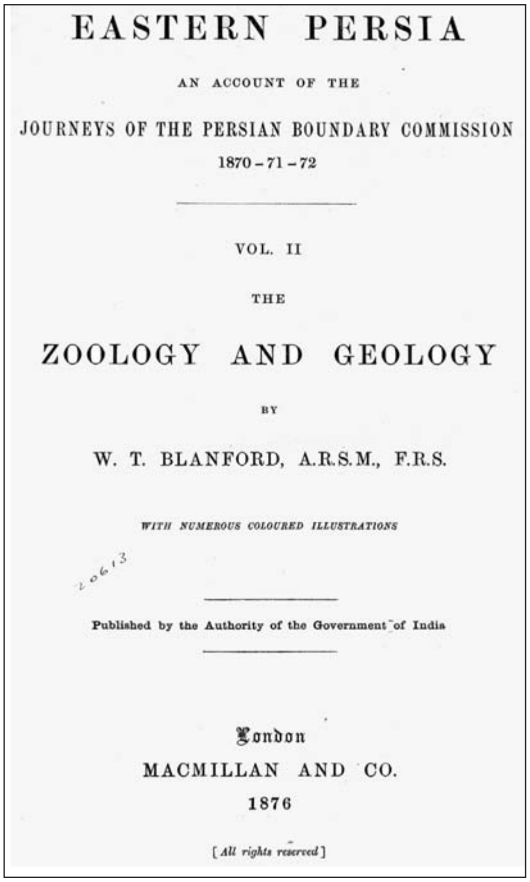
Although water as an agent of erosion loomed large in Blanford's mind, he was also much interested in the volcanics and basalt flows he observed along the route of march. For instance, in speaking of the trap rocks (Fig. 21) of the Ashangi group in the vicinity of Belago Camp, he observed,

> The lower group consists entirely of doleritic rocks . . . frequently coated with green earth [glauconite ?]. . . . Nothing, however, can be considered as ascertained concerning the age of these traps, except that they are not older than oolitic [Jurassic]. In mineral character, they strikingly resemble the great trappen series of Western India; the resemblance even extending to such minute peculiarities as the frequent occurrence of agate or zeolite covered with green earth, and the existence of a peculiar porphyritic basalt with tabular crystals of feldspar. The age of the Indian traps has of late been shown to be almost certainly, in great part at least, upper cretaceous; but resemblance of mineral character is hardly sufficient alone to connect rocks in countries so widely distant from each other as Abyssinia and Bombay. Still, somewhat similar beds are known to occur in places along the coast of Arabia, underlying the nummulitic series, just as the Bombay traps do in Guzerat and Cutch, it is a very interesting question for future investigation, what connexion exists between . . . the lower tertiary traps of South-western Asia and Eastern Africa? Should they be proved to have been formerly connected, and to be portions of the same great ancient volcanic origin, an idea which seems by no means improbable, their study will become one of very great interest as connected with the geological history of the earth's surface. (W. Blanford *Abyssinia*:183–185.)

The above was written in late 1868, after Blanford's return to India. It is almost certain that William and his brother Henry talked about this notion of a connection because in 1873, in the small book on Indian geography written by Henry for high school and college students in India, he speaks of an "ancient land" connecting India, South Africa and the Seychelles. And, as earlier noted, three years later, he greatly expanded this to encompass Australia, India, and Africa, thus creating an "Indo-oceanic Continent" (but see also H. Blanford, 1875:534–535 for the introduction of a "Great Southern Landmass").

FIGURE 22. "Castle of Aibí-Kalagán — Balúchistán," near Gardwar, along the Makran Coast, Baluchistan. (St. John 1876a: unnumbered pl. facing p. 1 of St. John's report on "Physical Geography," in Goldsmid (1876).

In December 1871, Blanford's request to the Viceroy to join Major Oliver St. John in his travels through eastern Persia was approved. Blanford met up with St. John in Gardwar (Fig. 22), on the Makran Coast, Baluchistan, and the two traveled to Tehran via Persepolis, Karman, and Isfahan. The route followed mostly along the base of hills offering Blanford few oppor-



EASTERN PERSIA

AN ACCOUNT OF THE

JOURNEYS OF THE PERSIAN BOUNDARY COMMISSION

1870 – 71 – 72

VOL. II

THE

ZOOLOGY AND GEOLOGY

BY

W. T. BLANFORD, A.R.S.M., F.R.S.

WITH NUMEROUS COLOURED ILLUSTRATIONS

Published by the Authority of the Government of India

London

MACMILLAN AND CO.

1876

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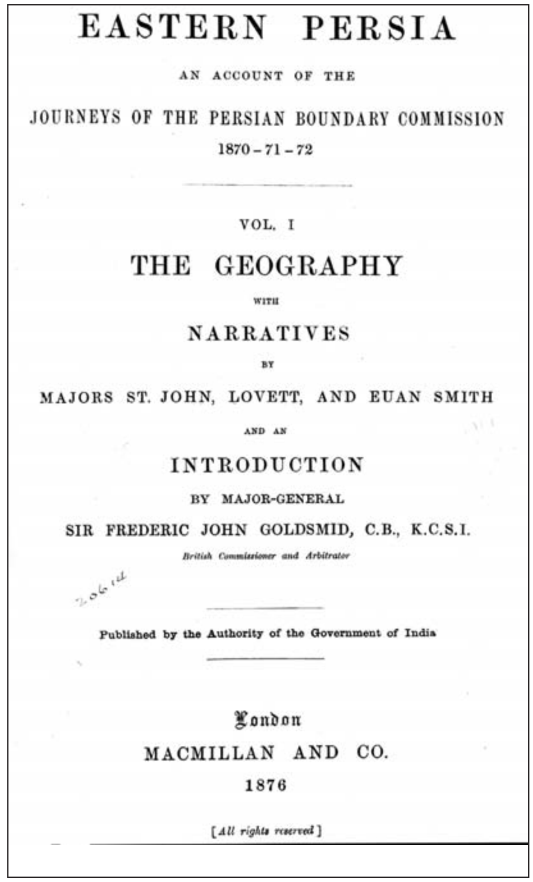

EASTERN PERSIA

AN ACCOUNT OF THE

JOURNEYS OF THE PERSIAN BOUNDARY COMMISSION

1870 – 71 – 72

VOL. I

THE GEOGRAPHY

WITH

NARRATIVES

BY

MAJORS ST. JOHN, LOVETT, AND EUAN SMITH

AND AN

INTRODUCTION

BY MAJOR-GENERAL

SIR FREDERIC JOHN GOLDSMID, C.B., K.C.S.I.

British Commissioner and Arbitrator

Published by the Authority of the Government of India

London

MACMILLAN AND CO.

1876

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FIGURES 23–24. (23, left) Title page of W.T. Blanford's report on the geology and zoology of Eastern Persia (1876). (24, right) Title page of the volume on Eastern Persia, edited by General Sir F.J. Goldsmid, including his and his staff's reports on their travels in Eastern Persia during the course of the Persian-Baluchistan boundary survey.

FIGURE 25. Titled "Breakfast with the Amir of Kain," from Goldsmid (1876, frontispiece).

tunities to explore the mountains with care. Although observations were limited, Blanford was still able to confirm many earlier observations made by W.K. Loftus during 1849–1852 on the Turkey-Persian Boundary Survey on the distribution of sedimentary and volcanic rocks, and he was able to add new observations on the Elburz Mountains, north of Tehran, which he visited. He thought they were older than the Zagros, saying that the former consisting largely of Paleozoic and Mesozoic rocks, the latter Cretaceous and early Tertiary. Both William Blanford's (1876c) (Fig. 23) and St. John's published reports (1876a–b) (Fig. 24) contain a wealth of interesting observations. St. John's reports were included in a volume edited by General Sir Frederick John Gold-smid, who added many interesting observations of his own, including, as political intelligence, observations on local

FIGURE 26. Hydrographical map of Persia (St. John 1876a: Diagr. 1 (facing p. 3).

customs, for instance, "Breakfast with the Amir," (Fig. 25) and even genealogies of ranking families in Sistan and Baluchistan (Goldsmid 1876).

The hydrographic character (Fig. 26) of the Persian (Iranian) Plateau caught Blanford's attention, as it did St. John's, but Blanford's observations are of greater interest here because they dealt with geomorphic and geologic features. From Blanford's Persian trek, two key observations emerged: (1) that the edges of the Persian plateau everywhere are higher than its interior and everywhere in Persia except along the coast of the Persian Gulf and Arabian Sea and the western watershed of the Zagros and Kurdistan Mountains, no river has an outlet to the sea, and (2) the surficial deposits in valleys of central Persia suggest greater rainfall in former times and a gradual decrease at present, a point that he further developed when he speaks about the formation of the great alluvial fans that dominate the interior valleys,

> As the rainfall farther diminished, the lakes gradually dried up, and the streams which had formerly carried down the detritus of the hills now only transported such debris as rain and frost detached from the surface to the base of the incline, where it formed a long slope of gravel and sand such as we now see on the edges of the deserts. That a paucity of rainfall is the cause of these enormous slopes of gravel appears probable from the fact that similar accumulations appear throughout the world to be characteristic of comparatively dry climates."(W. Blanford *Persia*:470.)

Blanford, ever aware of the towering Zagros Mountains that he on occasion passed through or around, and reflecting on his earlier work in India, notably in Orissa and the Bombay Presidency, and in Abyssinia, observed,

> It is evident that during the cretaceous times the greater portion and probably the whole of Southern and South-western Persia was beneath the sea. We know that at this period there was a great development of land in what is at present part of the Indian Ocean south of Persia and Arabia, and that very probably land communication existed between India and Africa. (W. Blanford *Persia*:468.)

Then, still groping for that elusive explanation of how mountains come into being, yet wedded to an earlier age, Blanford writes,

> Towards the close of the cretaceous epoch a great change took place accompanied by volcanic outbursts in the Caucasus, over a great area in Western India, and probably in several parts of Persia, and the result was the elevation of the Zagros range, and perhaps parts of the country now forming the Persian plateau. (W. Blanford *Persia*:468.)

William Thomas Blanford as Naturalist and Biogeographer

Although by profession a geologist, Blanford was also a Victorian naturalist of considerable accomplishment. Field work included both geology and zoology, and he spent considerable effort collecting samples of the many interesting animals encountered, especially birds, reptiles, and mollusks. These collections, most of which went to the British Museum in London and the newly established Indian Museum in Calcutta, were worked up by Blanford himself and published as chapters, including many exquisit color lithographs, in both his Abyssinian and Persian reports. Ferdinand Stoliczka was of like mind, and he too collected widely, rocks, fossils, and significant numbers of amphibians and reptiles during his reconnaissance marches in the Himalayas and along the route to Yarkand. One need only thumb through the zoological plates accompanying Blanford's Abyssinian (Fig. 28) and Persian reports (Figs. 29–30) and Blanford's paper on Stoliczka's collections from the Yarkand expedition to appreciate their extraordinary talents as field naturalists. But, more importantly, one can quickly understand how is came to pass that Blanford was able to challenge the naturalist gurus of his day, notably Alfred Russell Wallace (Fig. 31), when it came to matters of biogeography. Indeed, as early as 1870 he pointedly observed that although "it has been invariably assumed that the fauna of India proper and the Malay countries identical . . This is not the case, . . . but the fauna of the plains of India generally is, if anything, more closely allied to that of Africa than to that of Malayasia." (Blanford 1870:107.) His understanding of faunal relationships was not limited to recent or fossil animals but encompassed both as well as a finely honed knowledge of stratigraphy.

Putting It Together

So, where does this lead. In 1876, Blanford wrote a critique of Alfred Russell Wallace's just published two-volume work, *The Geographical Distribution of Animals*, which had an enormous and enduring impact on biogeographers and many Tertiary vertebrate paleontologists, especially in North America, well into the late 20th century. In his opening remarks, Blanford notes that he had as early as 1869 published a note on the distribution of Indian reptiles, but that in lacking details, he was "not surprised to find that my opinion has had but little weight with any who had NOT a personal knowledge of the country." (W. Blanford 1876b:277.) He then drew on his considerable knowledge of geology and zoology to examine in a systematic, judicative tone, the supposed factual basis of Wallace's adaptation of Philip Lutley Sclater's (Fig. 27) 1858 rendering of zoogeographic realms, based initially on birds but then modified by Wallace to include living mammals (see also Sclater 1874). Blanford not only challenged that approach, pointing out that geographical realms based on other and unrelated groups of living animals and plants would yield quite different arrangements; he also challenged current taxonomies by positing, "I have long been convinced that many of the usual generic groups are artificial; and some are even founded on geographic distribution — forms which inhabit Africa being placed in a different genus from those which inhabit India on account of a difference in locality . . ." (W. Blanford 1876b:277). Blanford then cited earlier work by Edward Blyth, on mammals and birds in 1871, and Ferdinand Stoliczka, in 1869, on Cretaceous ammonites from South India, noting that both recognized the Ethiopian affinities of the Peninsula Indian fauna, which Wallace did not.

FIGURE 27. Philip Lutley Sclater. (Courtesy GS Myers/AE Leviton Portrait & Biographical File in the Natural Sciences, Archives, California Academy of Sciences.)

Having said this, Blanford sought to differentiate geologically recent from much older events, arguing that "in all probability Africa has been separated from India long enough for the same or allied species in the two regions . . . to have become sufficiently distinct . . ." to be referred to distinct higher taxonomic categories (W. Blanford 1876b:280). In short, you have to know something about genealogical relationships, i.e., phylogenies, to understand biogeographical patterns.

In 1879, Henry Medlicott and William Blanford authored the first edition of *A Manual of the Geology of India*. In that handsome volume, they take up the matter of the Gondwana System in depth. They posited the ages of the Lower Gondwánas as Permian and Triassic, "perhaps a little order or a little newer. . ." and the Upper Gondwánas as "more certainly . . . Jurassic." (Medlicott and W. Blanford 1879:xxviii). They also affirmed their opinion that in Lower Gondwánas time India, Australia and South Africa were united (Medlicott and W. Blanford 1879:xxxiv–xxxv).

Following his retirement in 1882, Blanford penned several contributions in which he drew heavily on his extensive field experience in Abyssinia, India, and Persia. In his 1886 paper on Paleozoic glaciation, which is both wide-ranging and perhaps even prophetic, Blanford emphasizedthe importance of a great glacial epoch at the close of the Paleozoic era and the great floral and faunal changes that took place between the Upper Paleozoic and lower Mesozoic. He noted that Forbes, in his presidential address to the Geological Society of London in 1854, had remarked on this very matter. Then, after a cursory examination of several contrasting explanations for the unusual event, he concluded, "It is at least equally probable that a considerable tract of Southern Asia in Carboniferous times formed part of a continuous land area extending to Australia on one side and to South Africa on the other, that this land area was absolutely severed from all the countries in which the Coal-measure flora existed at the time, and was subjected to a much colder climate." (W. Blanford 1886:260.)

In 1890, William Thomas Blanford gave the presidential address at the Geological Society of London. Once again he used Wallace as a point of departure to focus on currently held views of permanency of the ocean basins and continents. He opened the presentation with the statement, "The question of the permanence of ocean-basins . . . is one that has attained great prominence in

FIGURE 28. Plate from W. Blanford, *Abyssinia*: pl. 7.

FIGURE 29. Plate from W. Blanford, *Persia*: pl. 14.

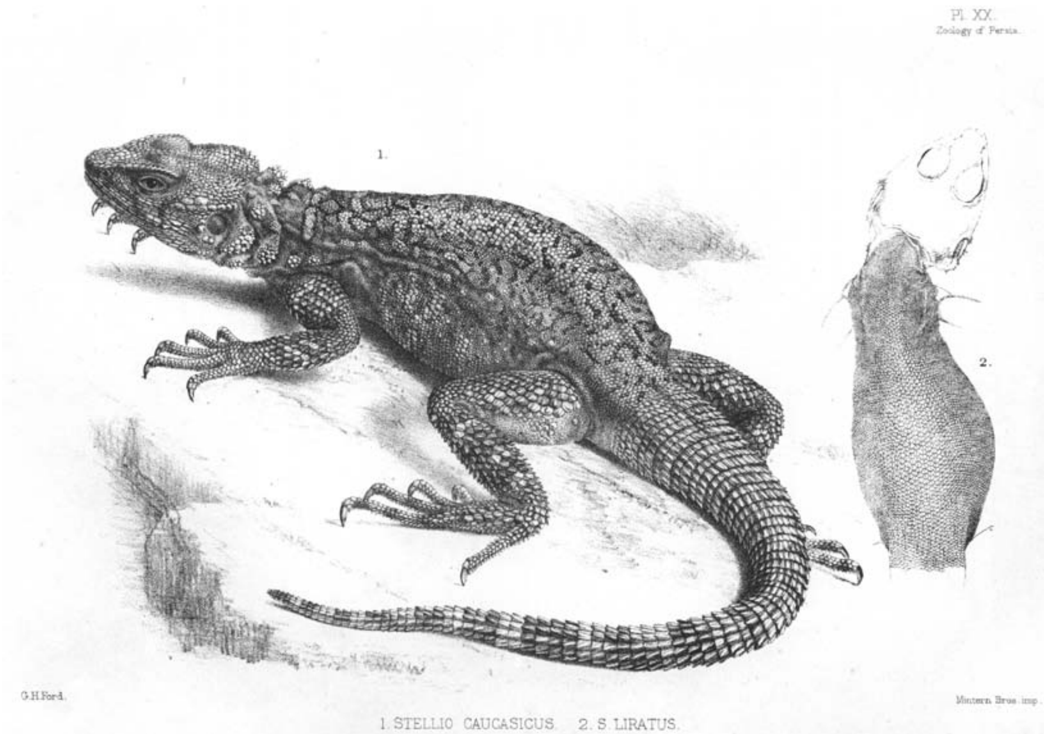

FIGURE 30. Plate from W. Blanford, *Persia,* pl. 20, illustrating *Stellio* [=*Laudakia*] *caucasicus*, a widely distributed member of the Family Agamidae.

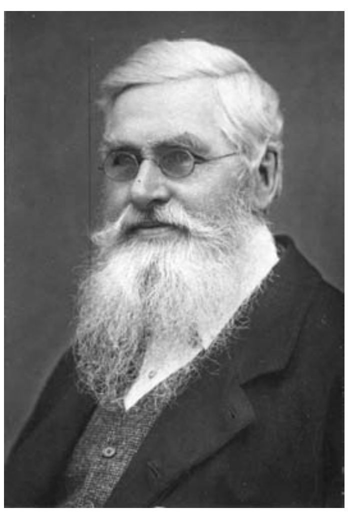

FIGURE 31. Alfred Russel Wallace. (Courtesy GS Myers/AE Leviton Portrait & Biographical File in the Natural Sciences, Archives, California Academy of Sciences.)

this country since the '*Challenger*' Expedition. The opinion that the deep parts of the ocean have been the same from the earliest period of which we have any record in the Earth's strata, has received the approval of several eminent geologists and biologists. Nonetheless there are many who feel grave doubts on the subject."(W. Blanford 1890:59) He then analyzed distribution patterns taking special note of recent forms, because those formed the structural basis of both Sclater's and Wallace's arguments. Blanford was critical, stating "Mr. Alfred Wallace, . . . has in his later works unhesitatingly given adhesion to the doctrine of permanent oceanic and continental areas in almost its extreme form." (W. Blanford 1890:67.) He argued that "the present distribution of animals and plants is of the highest geological importance, and that the existence of particular forms of living beings in continents and islands is the result and the record of the history of those areas and of their connexions with each other." (W. Blanford 1890:67.) He continued, "No one doubts that the present form of the great land-tracts extends back with but trivial modification to Pliocene times at least, the only important changes of later date being the opening of Behring's Straits, and severance of America from Asia, the separation from continents of certain continental islands, such as Great Britain and Ireland, Sumatra, Java, and Borneo, Ceylon, etc., and perhaps the reunion of North and South America. The changes since Miocene, and perhaps since Eocene, times have probably been neither very extensive nor very numerous." (W. Blanford 1890:69.) From here, Blanford launched into a point by point examination of patterns of distribution of living organisms, pointing out that criteria for one group of animals for successful migration are not necessarily the same for all others. He also argued that "Sclater's regions adopted by Wallace are convenient . . . they are, so far as they are natural, a necessary result of the present and later Tertiary distribution of land and water, and that they are, to a large extent, artificial." (W. Blanford 1890:83.) Thus, Blanford concluded, "the evidence [argued by Sclater and Wallace] is far too contradictory to be received as proof of the permanence of oceans and continents [at times more distant]." (W. Blanford 1890:83.) The balance of his address developed the argument in support of a great southern continent at one time or another during the Paleozoic and Mesozoic eras linking South America, Africa, India, Australia, New Zealand. He also remarked that ät some period of geological history an important continent, having connexions with South America, South Africa, and New Zealand, may have occupied the Antarctic area." (W. Blanford 1890:104.)

We cannot spend too much more time exploring the arguments, pro and con, relating to permanency of ocean basins paradigms. Recent contributions by Naomi Oreskes (Oreskes 1999) and others have treated this matter in considerable detail. Suffice to say, Blanford made it abundantly clear that he believes they were not, and he was not alone in holding such views.

Melchior Neumayr, in 1887, following in the footsteps of Sclater and Huxley, argued in favor of the mythical "peninsula" or land bridge Lemuria (Indomadagassia of Neumeyer), that stretched from Madagascar to India, including a spur line to the granitic Seychelles, even while advancing the notion of a broad continental connection between Africa and South America, which he based on stratigraphic and paleontologic evidence, a contrast with Engler's Archhelenis, which was a bridge-like connection between southern South America and Africa. And, though the land-bridge concept was not exactly what Blanford had in mind in dealing with India and Africa, Neumayr's paper allowed Blanford, in 1890, and Suess, in 1894, to close the gap and incorporate South America into Gondwanaland. Although the Blanfords had much earlier argued for a southern landmass that included Africa, India, and Australia, the latter was not part of Gondwana-Land when Suess coined the term 1882 for a Paleozoic-Mesozoic southern landmass, then consisting only of Africa and India. As an aside, the introduction of land bridges by Huxley, Sclater, and Engler, in contrast to broad continental connections by Blanford, Neumayr, and Suess, led to a proliferation of bridge building that in the early part of the 20th century was to fill the ocean basins an amazing assortment of "bridges" allowing for temporary migration routes to accommodate nearly every beast that needed to cross an ocean barrier (e.g., Figs. 32–33 fromvon Ihering, 1927).

In closing, how do we evaluate the extra-limital work of the Survey? For a possible answer to this, we turn to Eduard Suess (Fig. 34) and his monumental work, *Das Antlitz der Erde*, published in four volumes between 1885 and 1909. As pointed out by Mott Greene, one of Suess' goals in his global synthesis was to enlarge on the meaning of uniform change, allowing for varying rates, as well as allowing for causes that are not necessarily observable at present (Greene 1982:166). Certainly, the work of GSI geologists offered fruitful examples for Suess to draw upon, and he did. If we allow, and we are not convinced that we should, that our modern fetish in academe for "Citation Index" offers a rational means of estimating a scholar's worth, i.e., how many hits for how many cited publications, then for argument's sake, perhaps we can allow that the number of times a person is cited by Suess is an indication of Suess' estimate of that person's contributions. In this regard, Geological Survey of India geologists, and most notably William T. Blanford, look

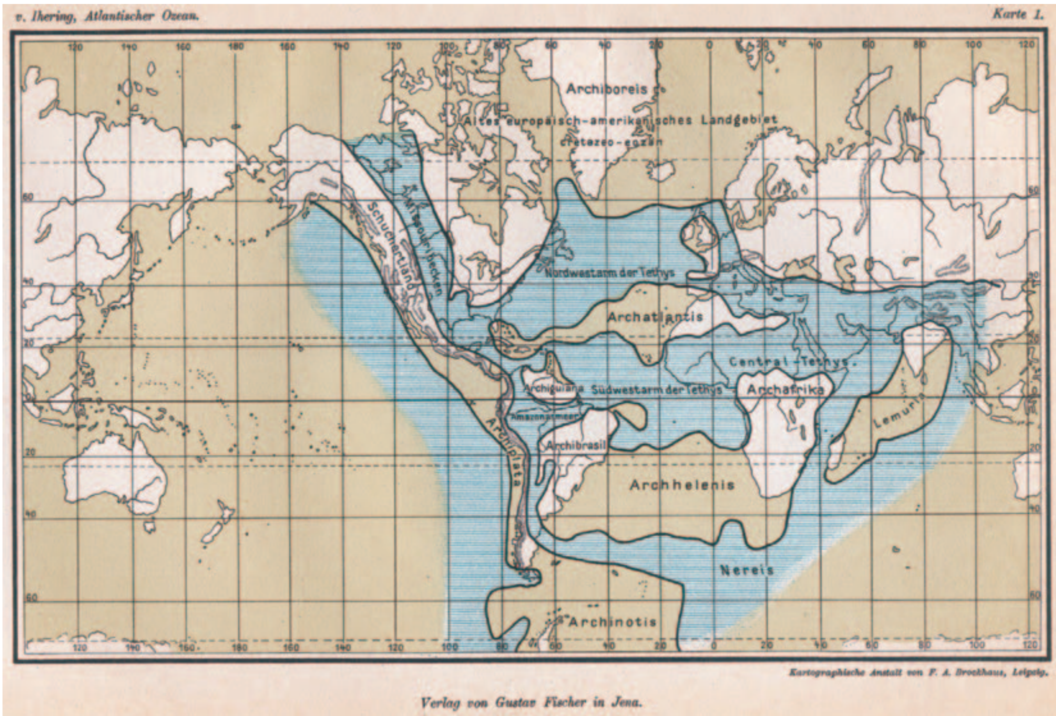

FIGURE 32. “Die Atlantisches Ozean und siner Randländer zur Zeit der oberen Kreide.” Terrestrial lands of the Atlantic and Indian Oceans during the Upper Cretaceous, from Hermann von Ihering, *Historisches des Atlantisches Oceans* (1927).

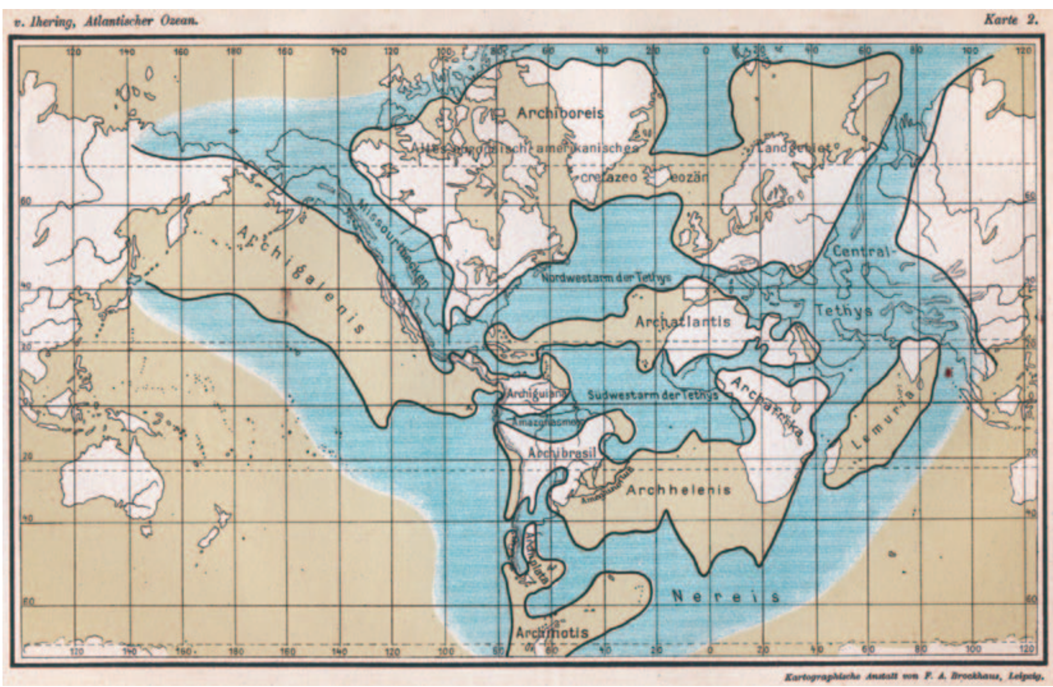

FIGURE 33. “Die Atlantisches Ozean und siner Randländer zur Zeit der Eozänes.” Terrestrial lands of the Atlantic and Indian Oceans during the Eocene, from Hermann von Ihering, *Historisches des Atlantisches Oceans* (1927).

pretty good. Using the index accompanying the original German edition, we find that Blanford, for instance, is cited 26 times, not as frequently as Dana's 36, but more often than Lyell at 19, Dawson, 13, Murchison, 11, and Hall, 6, among others. (Incidentally, Melchior Neumayr, Suess' son-in-law, is cited 40 times.) But, if all we have said is true, then why is so little recognition given to the Blanford brothers and others who plied their trade as members of the Geological Survey of India in the 19th century. We believe the answer lies in that fact that India is not western Europe or North America, and so does not engage the attention of the "industry" of historiographic researchers. Further, Eduard Suess' *Das Antlitz der Erde*, was so monumental it preempted all that came before. It became the encyclopedic reference for non-European and non-North American geology to which anyone could turn for a synthesis of earlier and of-times hard-to-find publications. Mott Greene aptly describes Suess as "The Second Global Tectonics." It is at once an end and a beginning.

FIGURE 34. Eduard Suess. (Courtesy GS Myers/AE Leviton Portrait & Biographical File in the Natural Sciences, Archives, California Academy of Sciences.)

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