



GeoContext:

*A social and political context
for geoscience education*

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Companion Document for “Isostasy”

Contributors: Harriet C.P. Lau

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People: Krishna Singh Rawat, Nain Singh Rawat, George Everest

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This companion guide accompanies the slides for “Isostasy.” For each slide, we provide additional context for content shown. We also provide suggestions for questions that can serve as class discussion prompts.

General Background Reading

Oreskes, N. (2002) *Plate Tectonics. An Insider’s History of the Modern history of the Earth.* Introduction.

Additional Context for Slides

Slide 2 | Isostasy was a key ingredient to corroborating the theory of plate tectonics. Confirming that the crust thickened both above and beneath the Earth’s surface in areas where plates collide was to an expected result. We learn this in every geology/geophysics class but how we came to learn this was ultimately a result of colonial activities.

Slide 3 | The British Empire had many reasons to conduct a detailed survey of India, culminating in a project named the Great Trigonometric Survey, funded by the East India Company¹ (a company formed during British exploits during Empire building).

¹<https://www.britannica.com/topic/East-India-Company>

Image: <https://herbologymanchester.wordpress.com/2015/05/27/cinchona-and-treating-malaria/>

Slide 4 | Examples include introducing plants from other regions and cultivating them in India for the benefit of British colonial commercial interests. This requires a detailed understanding of the land and climate.

Clements Markham suggested cultivating Chiconia for anti-malarial purposes. Another, perhaps more sinister example, is that the Brits aimed to produce opium and export to China, to balance trade (where British demand for silk and tea were very high). This kind of activity led to the infamous Opium Wars².

²“*The Opium War*”, Julia Lovell, Pan Macmillan Australia Pty, Limited, 2011

Slide 5 | So how does isostasy fit in? George Everest found that two different distances were measured between Kalia and Kalianpur depending on whether you used a Zenith Sector (astronomically based) versus a plumb line (gravitationally based). There was a 5 s difference in latitude when they used plumb lines to triangulate. Perhaps parts of the mountain were missing?

Enlisted John Pratt (Cambridge trained mathematician and archdeacon of Calcutta) to examine the problem. The topography of the mountain was compensated by a deficit of mass beneath them, where “Isostasy” equal standing. Either rock density was variable (Pratt), or thickness of crust (Airy) -- they could “float” on movable but denser substrate. But if rocks were squeezed together by convection - then Airy would be right.

Side note on the two types of isostasy. Pratt’s theory was confirmed by John Hayford and William Bowie, at US Coast and Geodetic Survey - distribution of gravity was most consistent with isostasy. Hayford and Bowie used Pratt for simplicity but it’s success at fitting observations across the US did not help the acceptance of plate tectonics. Airy isostasy was more widely considered in Europe.

Image of Zenith Sector: C. Strahan - Strahan, C. (1903). "[The Survey of India](#)". *Professional papers of the Corps of Royal Engineers* **28**: 141-171.

A [Zenith sector](#) was an upward facing telescope with accurate angle measurement scales. A star close to the zenith of known declination from the pole star was used to determine latitude as a direct measurement of the pole star could be affected by refraction.

Image of plumb line: https://en.wiktionary.org/wiki/plumb_line

Slide 6 | Pandits, natives who were allowed entry into places that the British were not, significantly helped the surveying effort. We do not acknowledge them in the western hemisphere, even though they are acknowledged in their home country.

Markham, in his writings, clearly cared for the local people he interacted with. But this was always from the position of self-assumed superiority.

Excerpts from Markham’s 1878 Memoirs of the Indian Surveys:

Thence they continued their journey in hammocks slung on bamboos, each carried by six men who kept on uttering unearthly discordant yells during the whole of the way to the village of Wundoor, a distance of six miles. From here they gradually ascended until they reached Ootacamund, the chief station on the

be able to record "that this great and important measure, fraught with blessings to the people of India, and with no less beneficial results to the whole civilised world, should have been finally attended with complete success, in spite of difficulties of no ordinary character."

behalf with his usual characteristic energy. One who had partially recovered from a severe attack of fever, and threatenings of paralysis, received, for an exhaustive and elaborate report on his work, the sum of £27! Markham made an earnest appeal for a small pension, but this was refused. It must be borne in mind that the whole cost of the expedition, which in 1880 was yielding to the Government an annual income of many thousands of pounds, was £857! Markham then brought the case to the notice of the Indian Government, but they merely transmitted his letter to the Secretary of State in London, without any recommendation or mark of approval, and it was, consequently, again rejected. The others were treated in a similar manner. No wonder that Markham, who knew their worth and the value of their services, was indignant at the treatment meted out to his fellow-workers. They had loyally supported him throughout the enterprise which had been entrusted to his guidance, and should have been correspondingly recompensed.

Thus, it will be seen that his sympathies, whether in India or South America, were invariably directed towards the amelioration of the conditions of life of the natives. Their interests and their happiness were ever uppermost in his thoughts. Even when visiting the various plantations, he was always careful to point out to the natives the importance of the use of quinine to themselves and the districts in which they resided, as well as the great benefits to be derived from it as a febrifuge.

Discussion Ideas

How does the wider context of beyond the isostasy story affect the practice of early geologists? While many colonialists, like Markham, cared for the Indian communities they interacted with, how damaging do you consider their somewhat condescending/superior nature of their attitudes to be?

