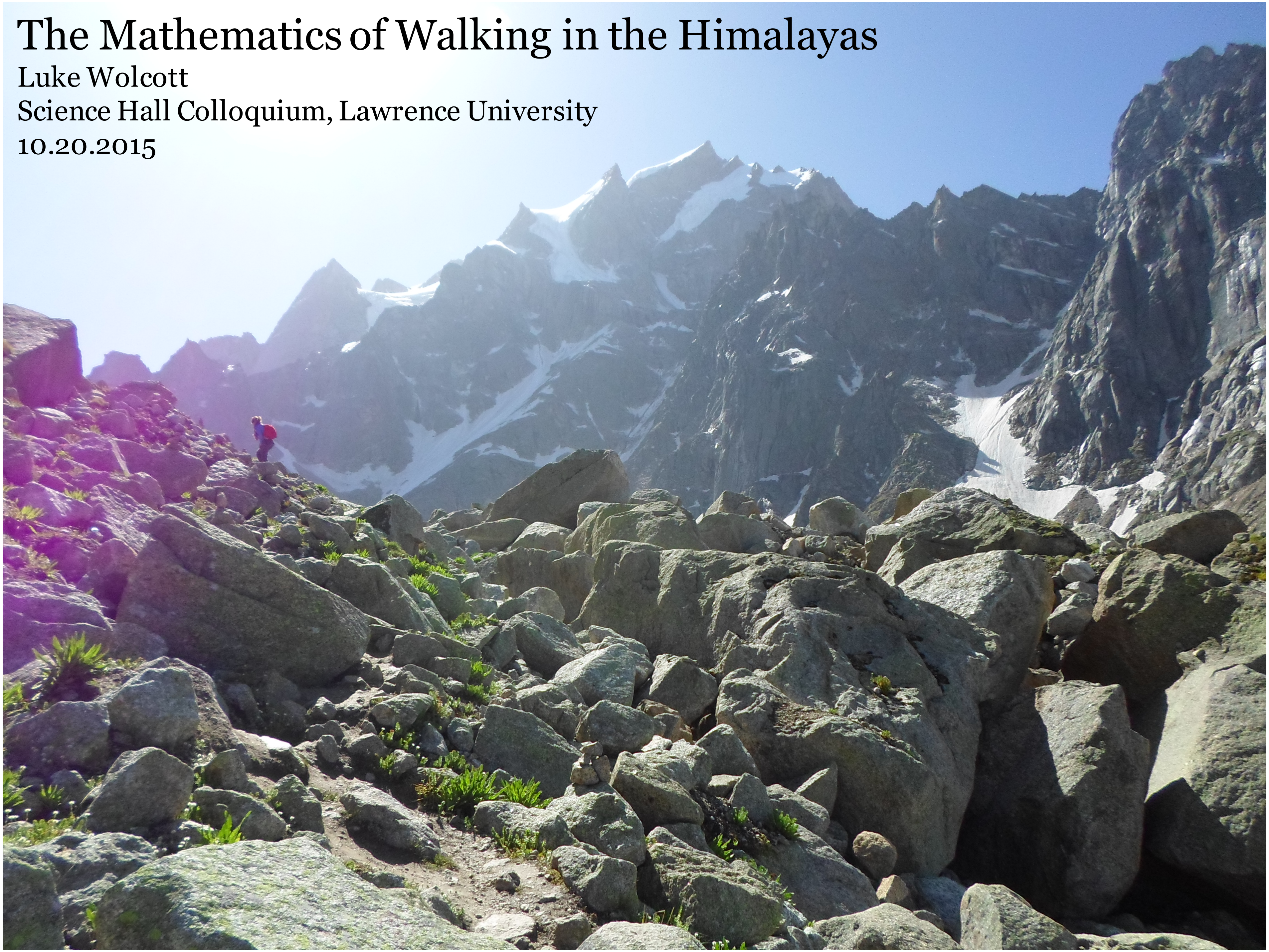
The Mathematics of Walking in the Himalayas

Luke Wolcott

Science Hall Colloquium, Lawrence University

10.20.2015

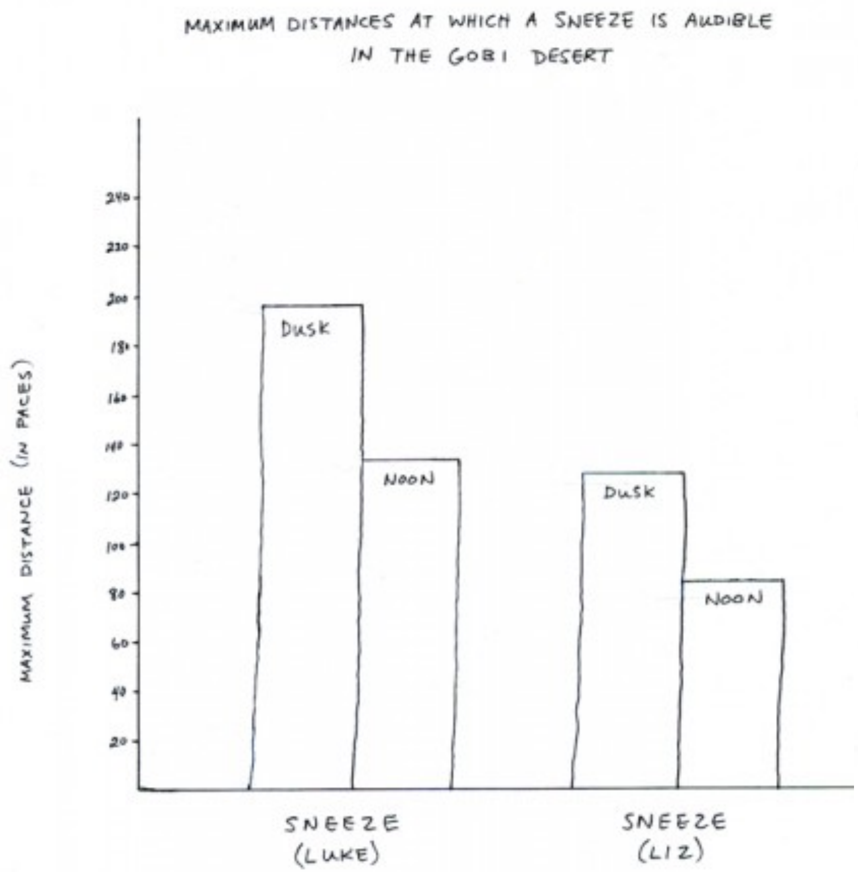


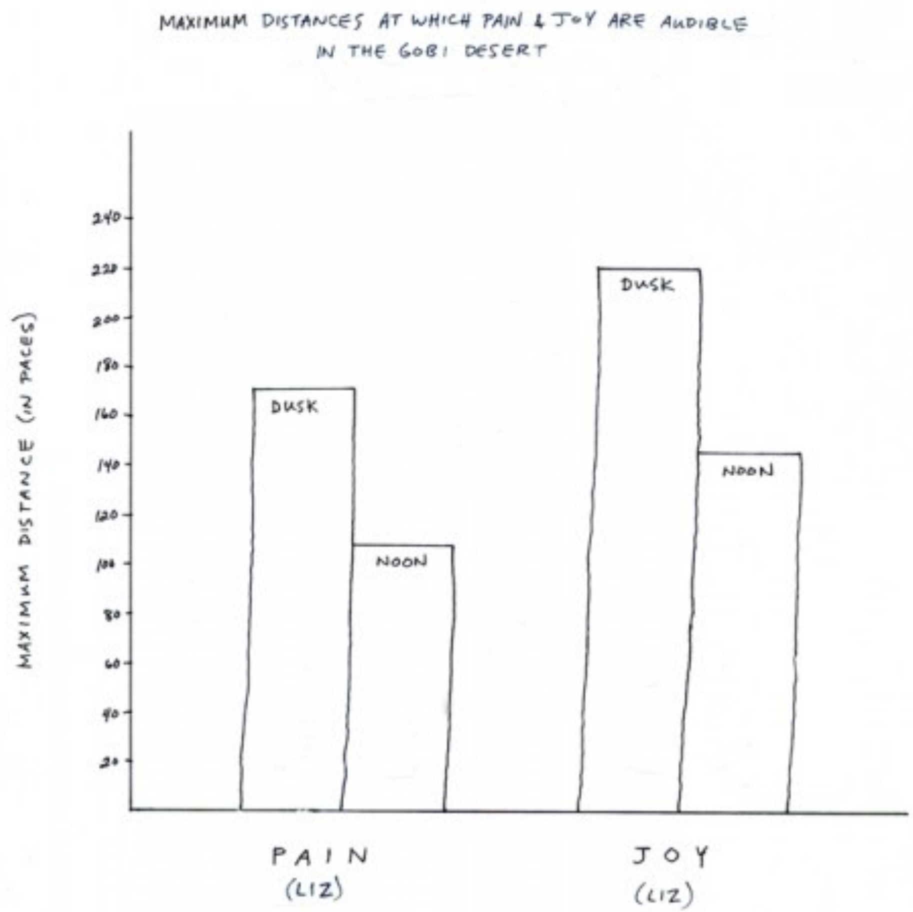
Outline:

1. Warm up by talking about earlier projects
2. The Great Trigonometrical Survey of India
3. Description of project, “Altitude sickness: angels and asteroids”

The possibility of walking through a wall
Elizabeth McTernan and Luke Wolcott
2007

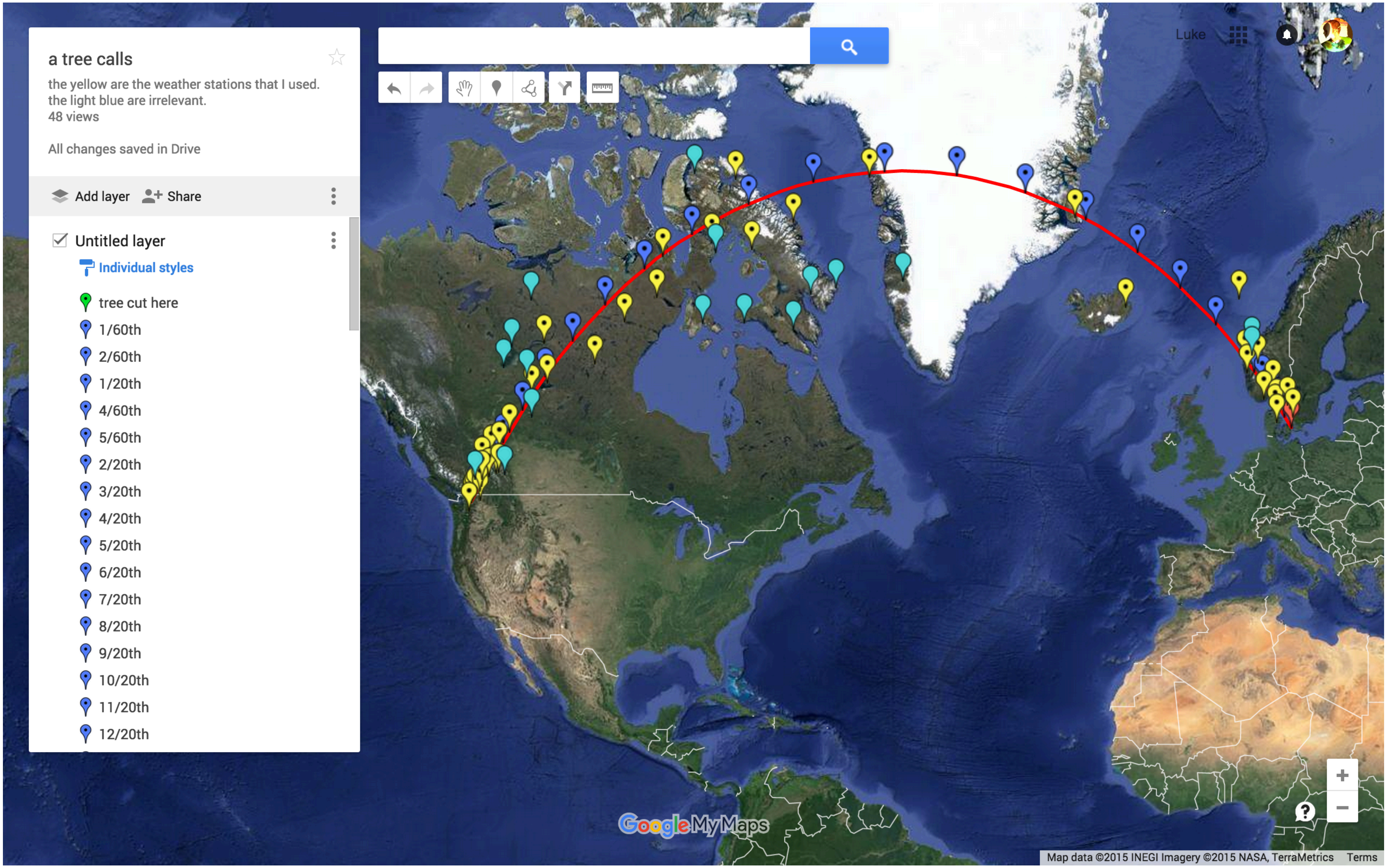
A very scientific sound & distance study
Elizabeth McTernan
2009


MAXIMUM DISTANCES AT WHICH A SNEEZE IS AUDIBLE IN THE GOBI DESERT
MAXIMUM DISTANCE (IN PACES)
240
220
200
180
160
140
120
100
80
60
40
20
DUSK
NOON
DUSK
NOON
SNEEZE (LUKE)
SNEEZE (LIZ)


MAXIMUM DISTANCES AT WHICH PAIN & JOY ARE AUDIBLE IN THE GOBI DESERT
MAXIMUM DISTANCE (IN PACES)
240
220
200
180
160
140
120
100
80
60
40
20
DUSK
NOON
DUSK
NOON
PAIN (LIZ)
JOY (LIZ)

A tree calls
Elizabeth McTernan
2012

6 hours, 31 minutes, 47 seconds
to travel 7686.35km
and arrive in central Copenhagen on 15 April 2012 at 15:31:47 local time


a tree calls
the yellow are the weather stations that I used.
the light blue are irrelevant.
48 views
All changes saved in Drive
Add layer
Share
Untitled layer
Individual styles
tree cut here
1/60th
2/60th
1/20th
4/60th
5/60th
2/20th
3/20th
4/20th
5/20th
6/20th
7/20th
8/20th
9/20th
10/20th
11/20th
12/20th
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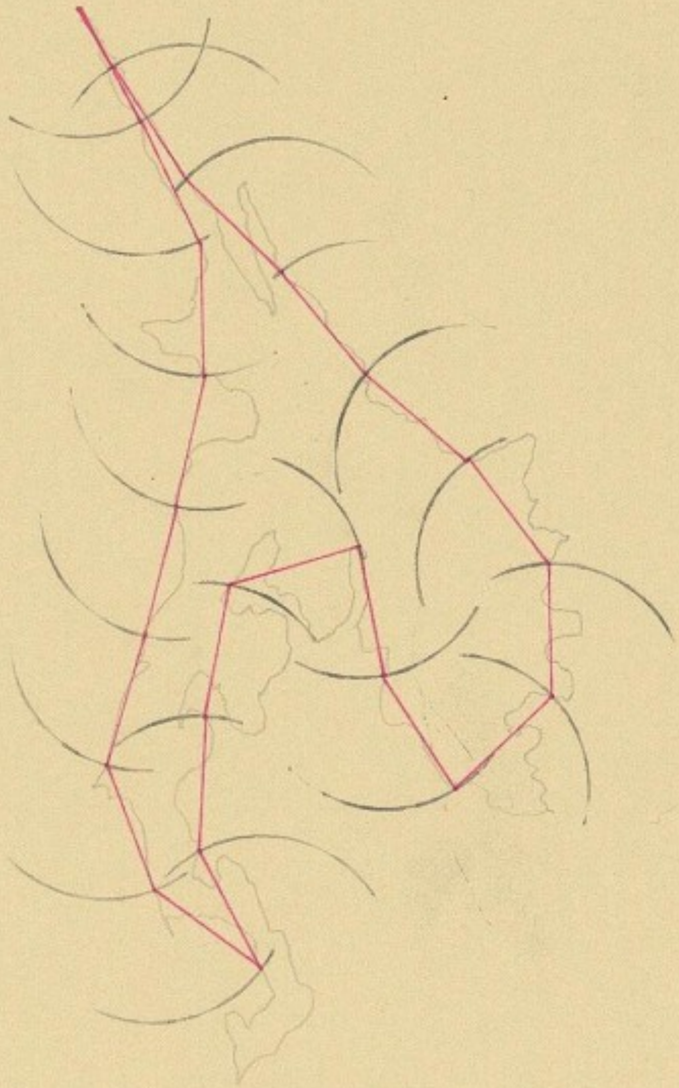
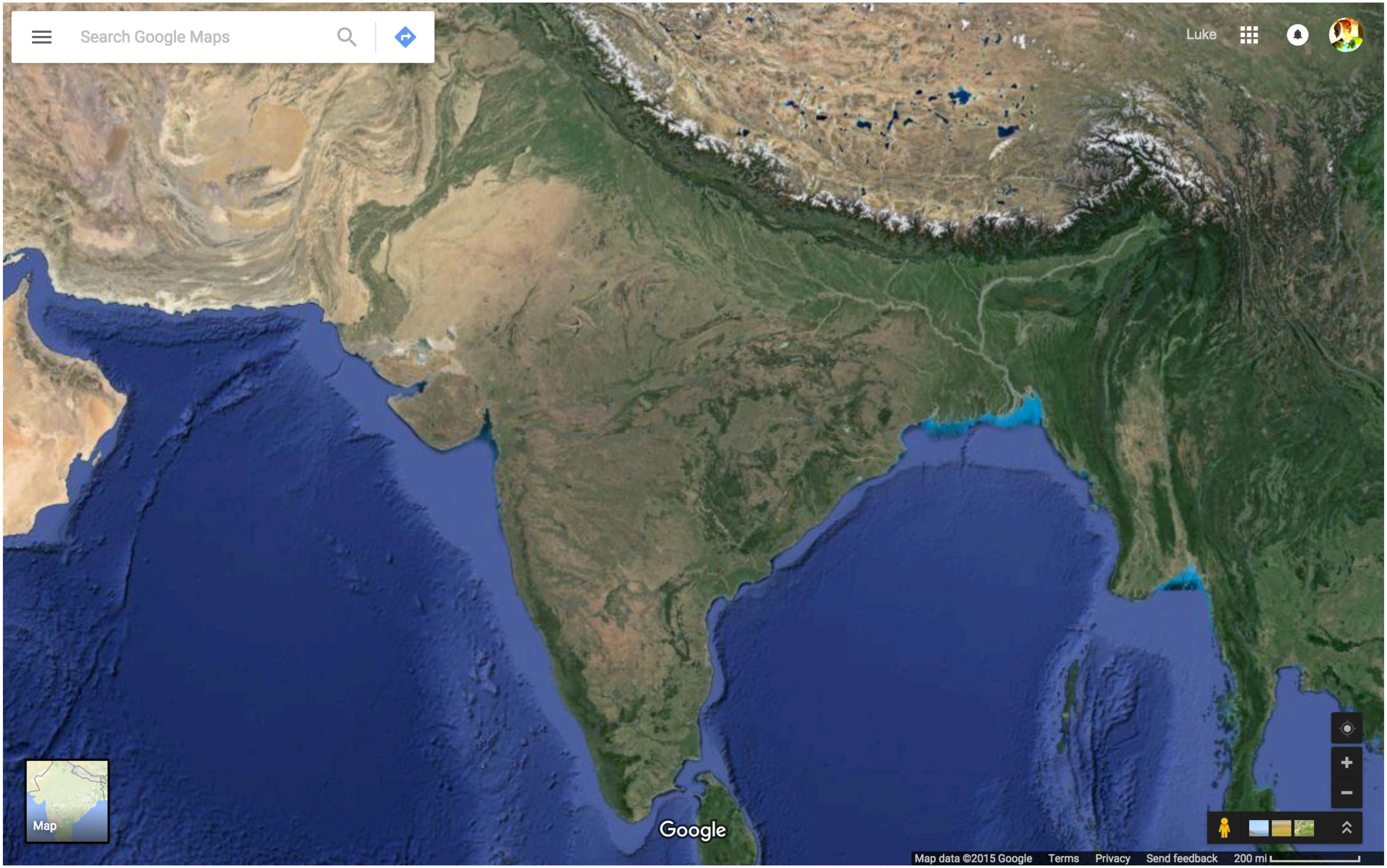
Danmark 1:25.000
A TREE CALLS Denmark (North)

the coastline paradox: measuring a nameless island
Elizabeth McTernan
2013

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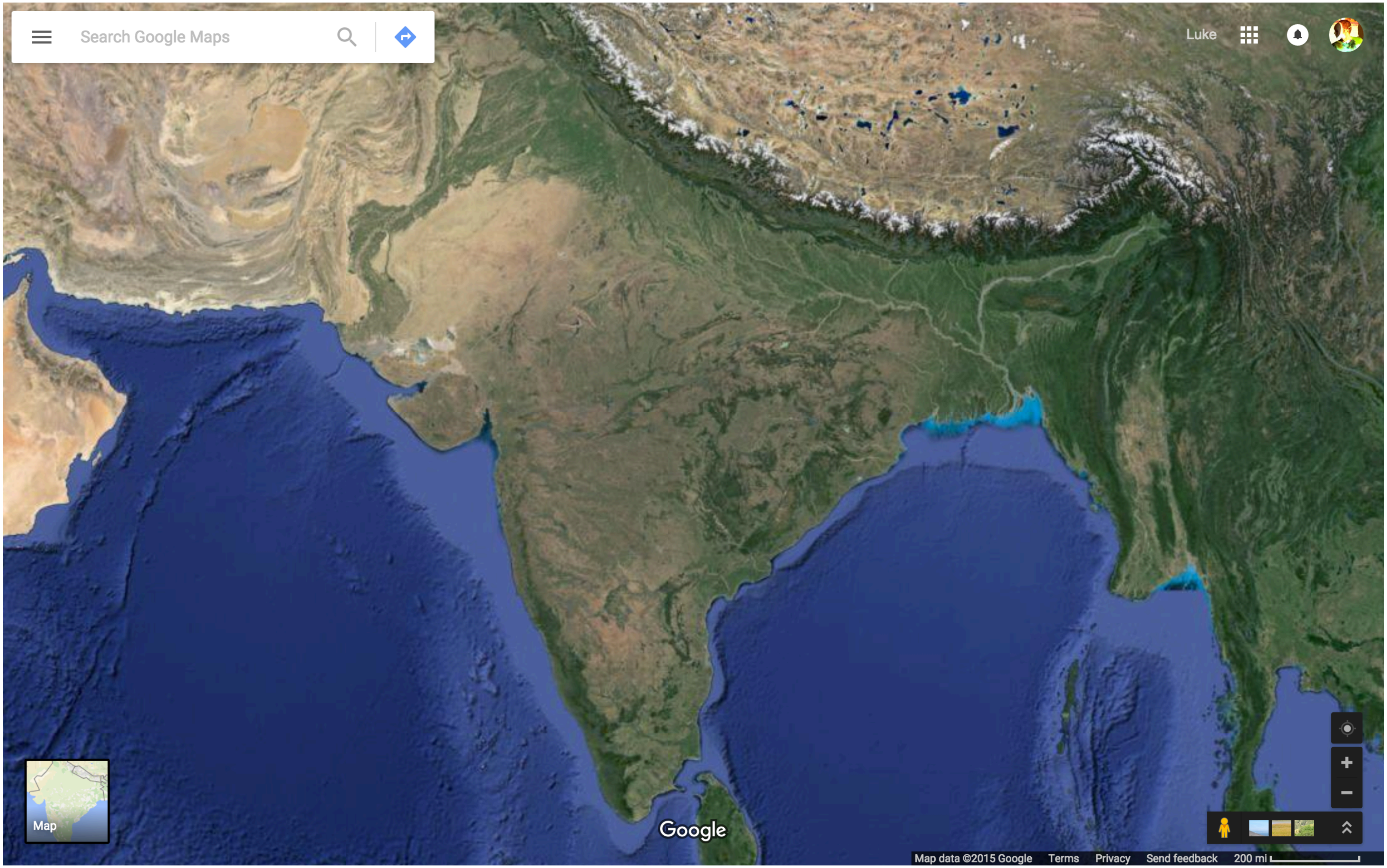
from *A Mathematician's Lament*, by Paul Lockhart:

SIMPLICIO: But we don't have time for every student to invent mathematics for themselves! It took centuries for people to discover the Pythagorean Theorem. How can you expect the average child to do it?

SALVIATI: I don't. Let's be clear about this. I'm complaining about the complete absence of art and invention, history and philosophy, context and perspective from the mathematics curriculum. That doesn't mean that notation, technique, and the development of a knowledge base have no place. Of course they do. We should have both. If I object to a pendulum being too far to one side, it doesn't mean I want it to be all the way on the other side. But the fact is, people learn better when the product comes out of the process. A real appreciation for poetry does not come from memorizing a bunch of poems, it comes from writing your own.

SIMPLICIO: Yes, but before you can write your own poems you need to learn the alphabet. The process has to begin somewhere. You have to walk before you can run.

SALVIATI: No, you have to have something you want to run toward...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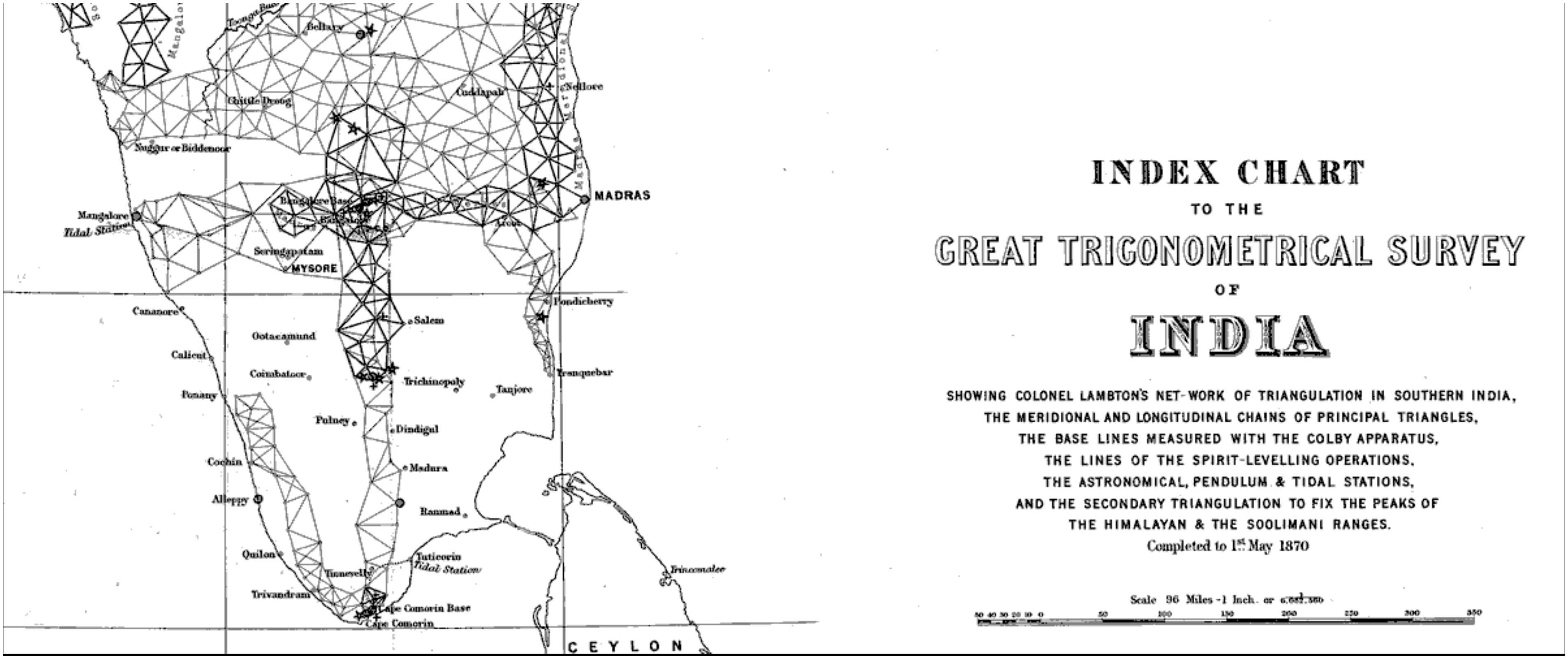
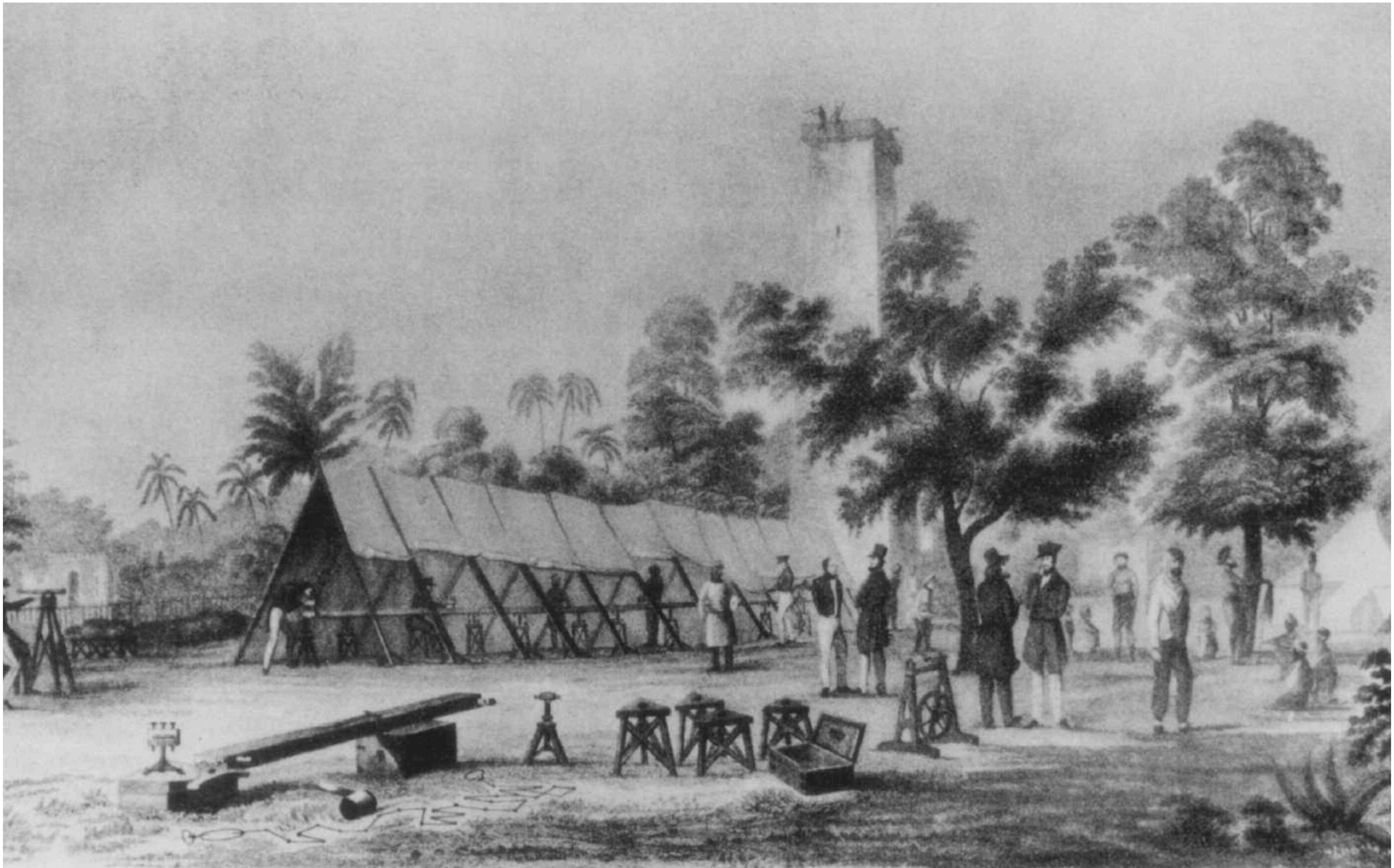
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
SHOWING COLONEL LAMBTONS NET WORK OF TRIANGULATION IN SOUTHERN INDIA,
THE MERIDIONAL AND LONGITUDINAL CHAINS OF PRINCIPAL TRIANGLES
THE BASE LINES MEASURED WITH THE COLBY APPARATUS
THE LINES OF THE SPIRIT LEVELLING OPERATIONS
THE ASTRONOMICAL PENDULUM & TIDAL STATIONS
AND THE SECONDARY TRIANGULATION TO FIX THE PEAKS OF
THE HIMALAYAN & THE SOOLIMANI RANGES
The course of the Levelling operations is shown by a dotted line
The stations where the Latitude has been observed astronomically by a star
The stations where an Azimuth has been observed astronomically thus
The Pendulum stations, thus
The Principal triangulation done before the year 1830 is shown by fine lines, after that year by thick lines.
No Secondary triangulation is shown excepting that to the peaks of the mountains on the northern frontier.
BAY OF BENGAL
BOMBAY
MADRAS
CEYLON
Photo-Reduction,
Geograph! Dept. India Office, London.



The Great Trigonometrical Survey of India. 1802 – 1860s.

How it works: triangulation

baseline measurement
+ angle measurements at ends
<u>+ law of sines</u>
= location of new point

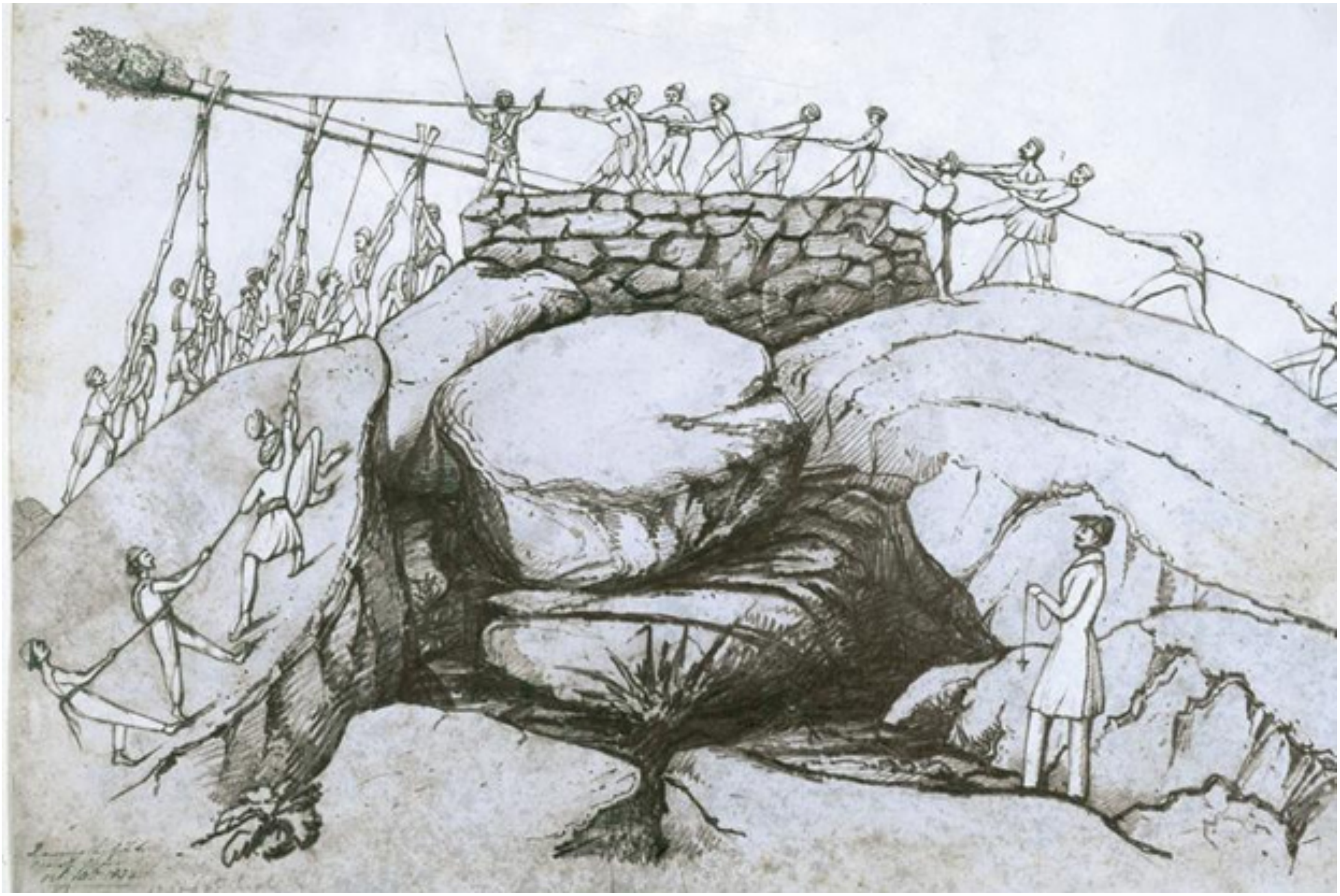


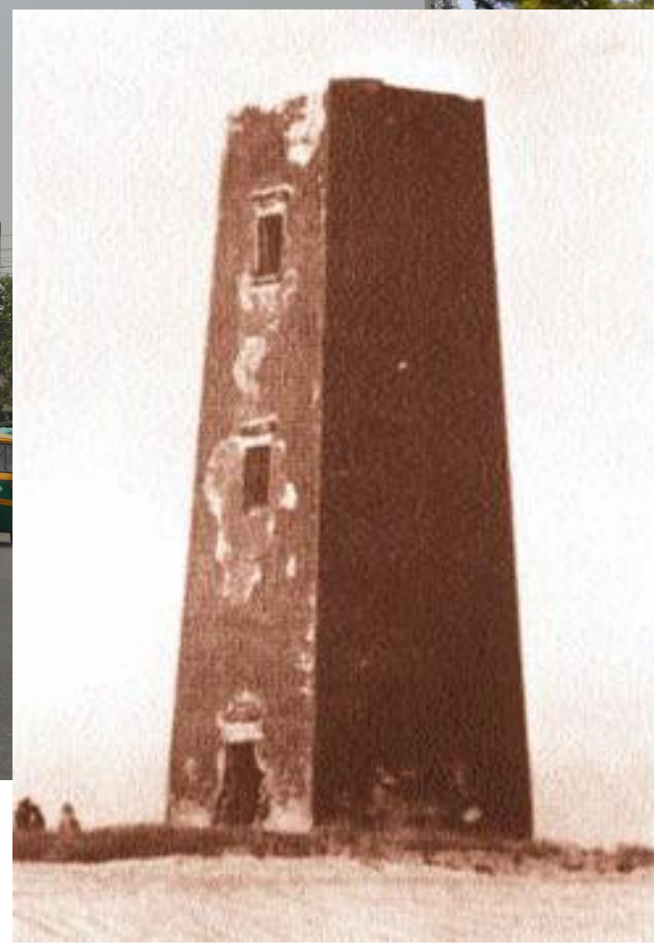
CALCUTTA BASE LINE

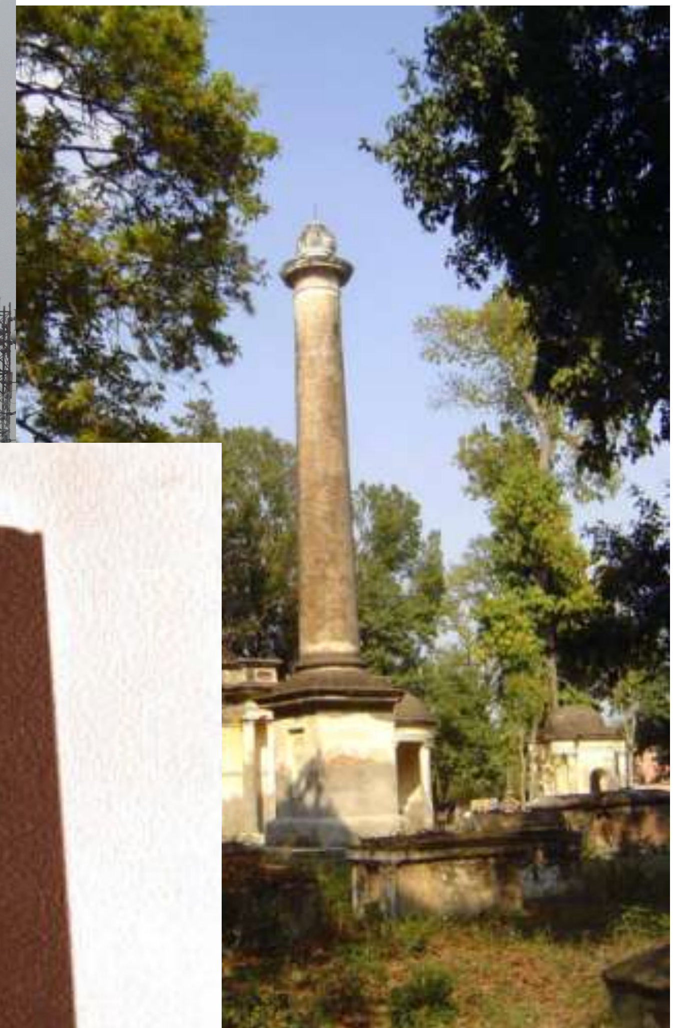
W. S. Sherwill.

Fig. 6. Chobman. Chainman. Fig. 7. Boundary Pillar. Fig. 8.

SURVEYING IN INDIA.





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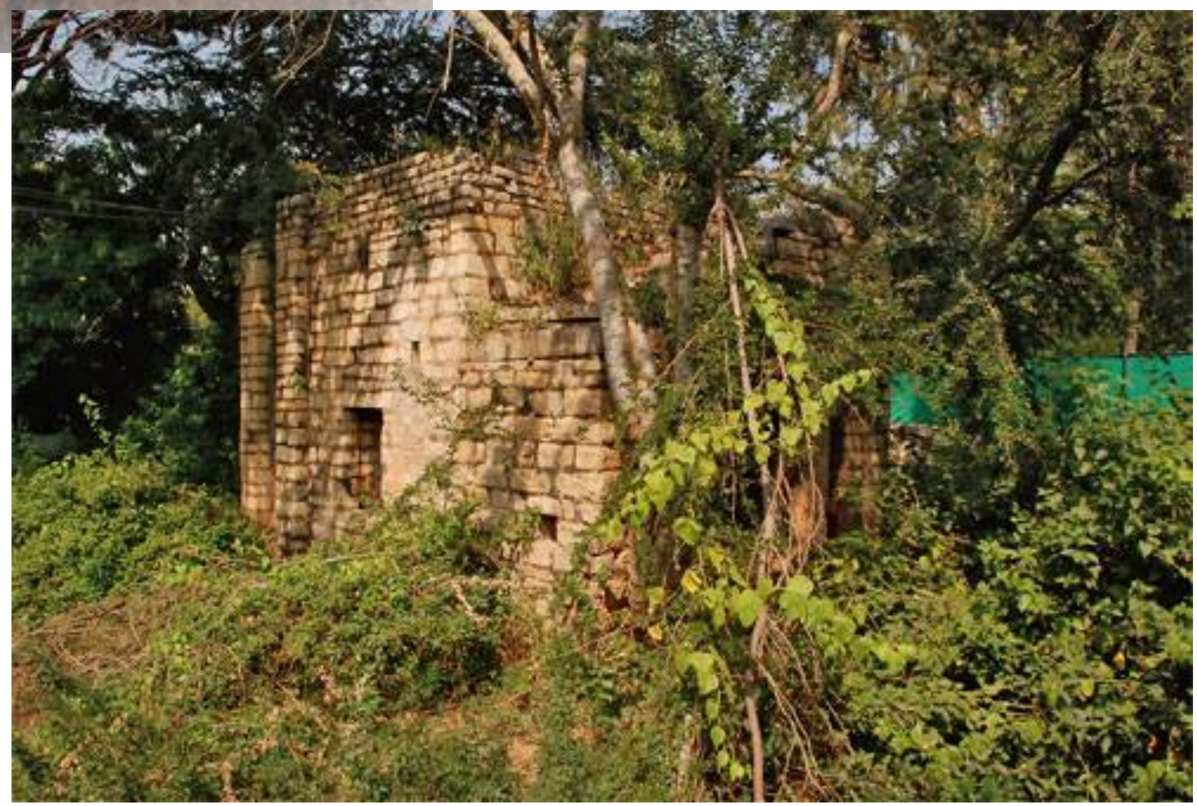
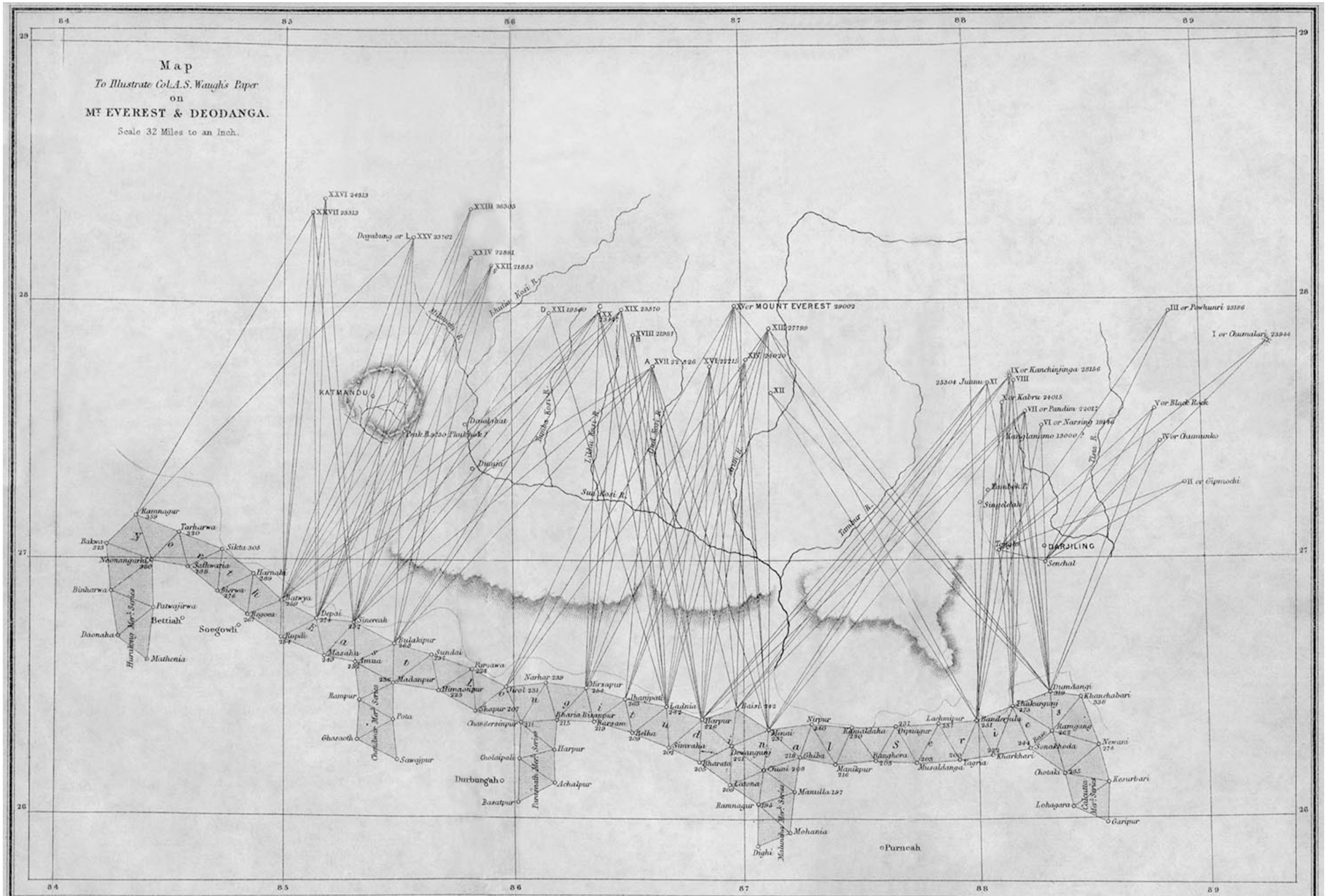
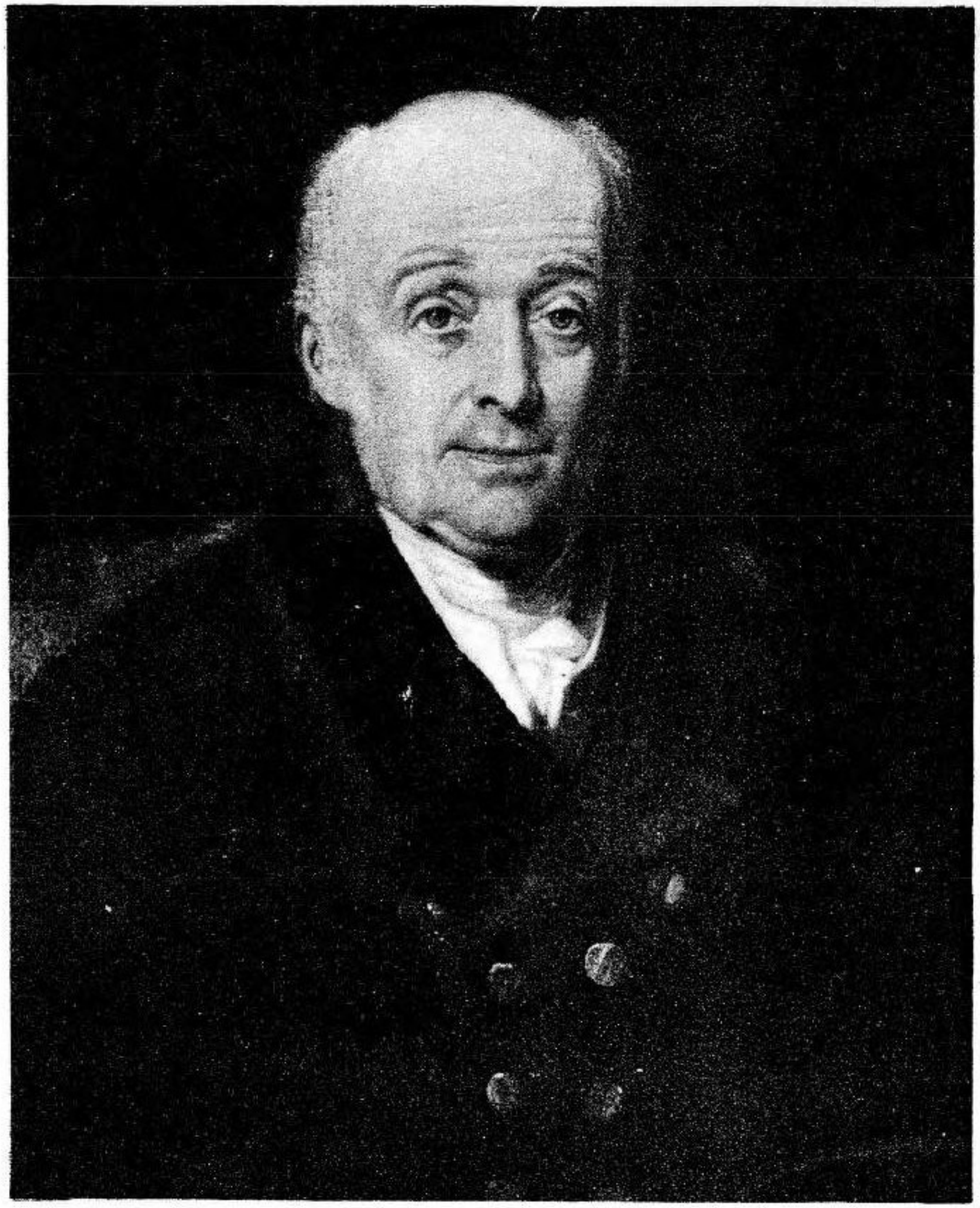


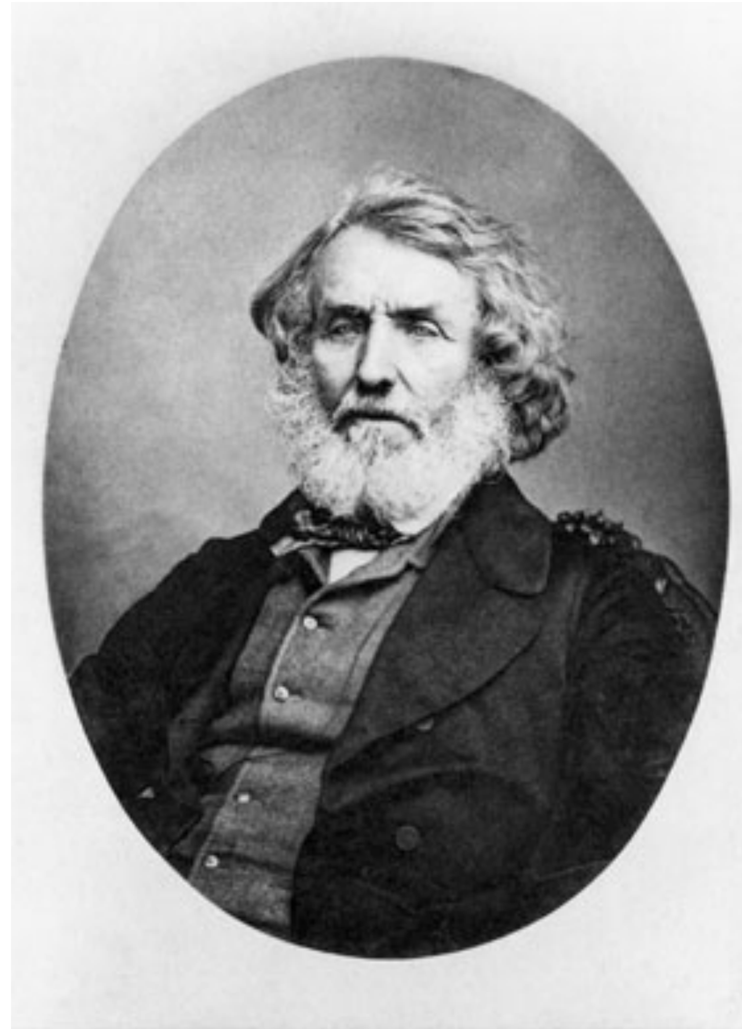


Published for the Royal Geographical Society. London 1858.

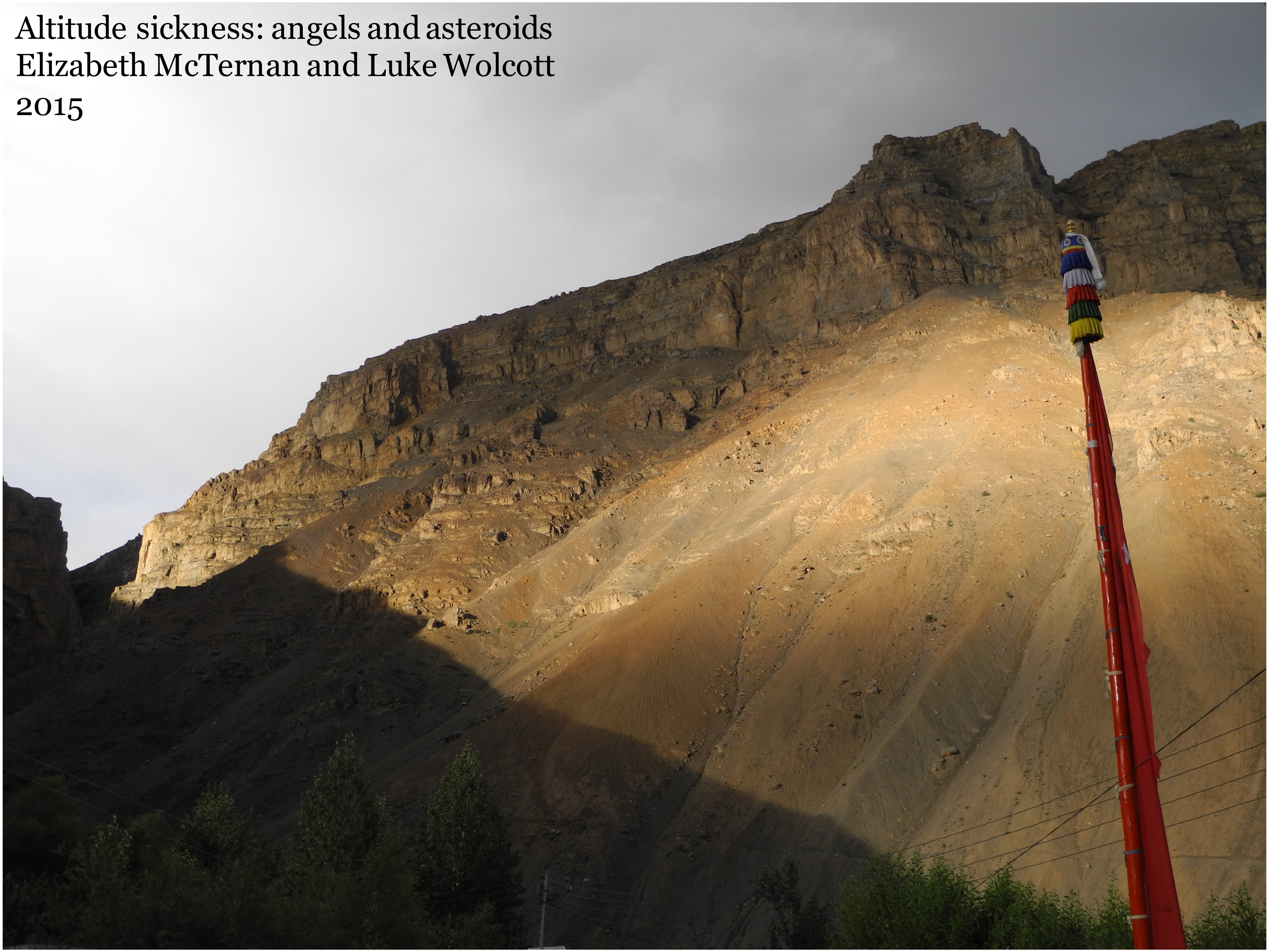
Edwd. Weller, Lithogr. Duke Str. Bloomsbury

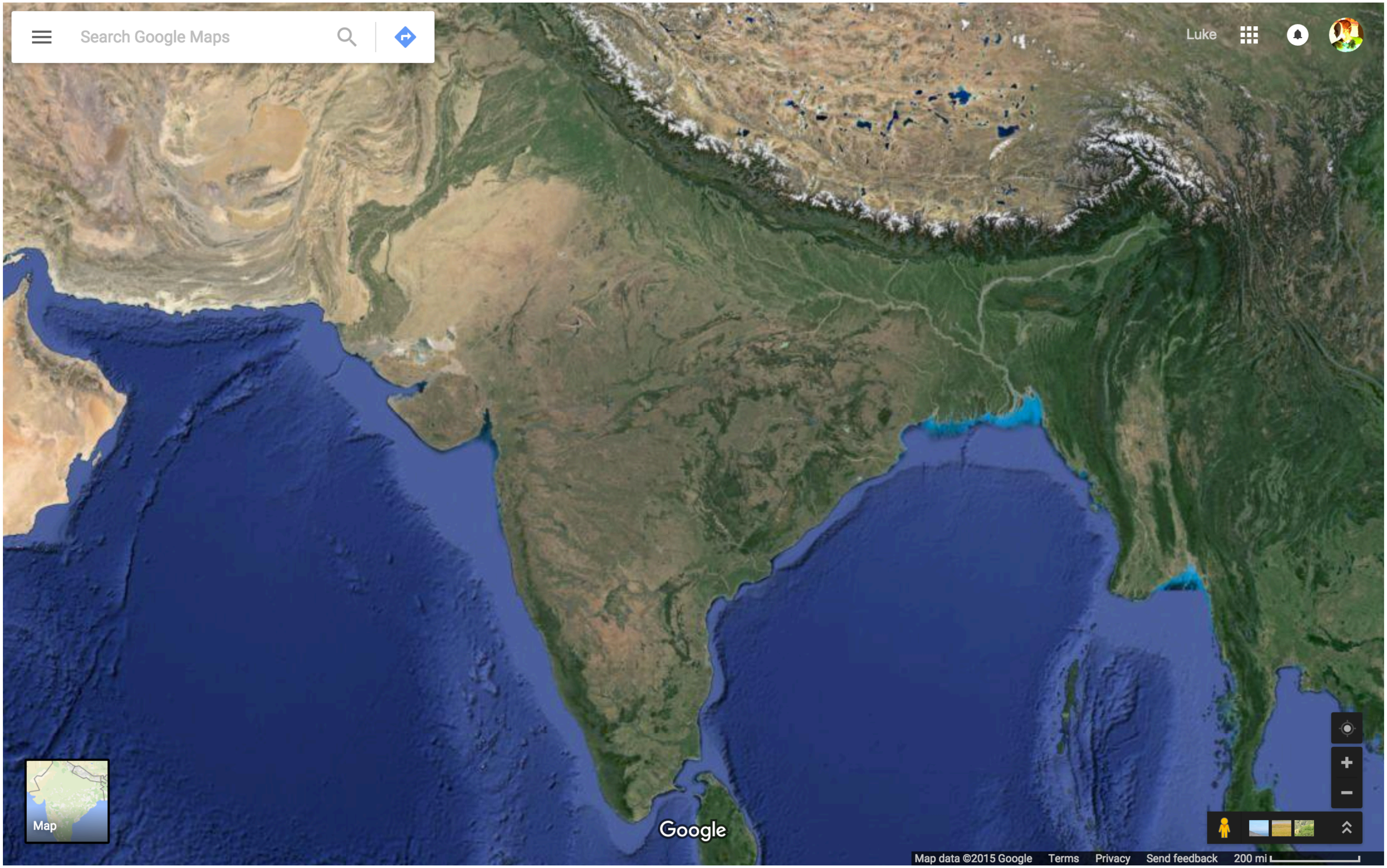


W Lambton



Superintendents of Survey:
William Lambton (1802 – 1823)
George Everest (1823 – 1843)


Altitude sickness: angels and asteroids
Elizabeth McTernan and Luke Wolcott
2015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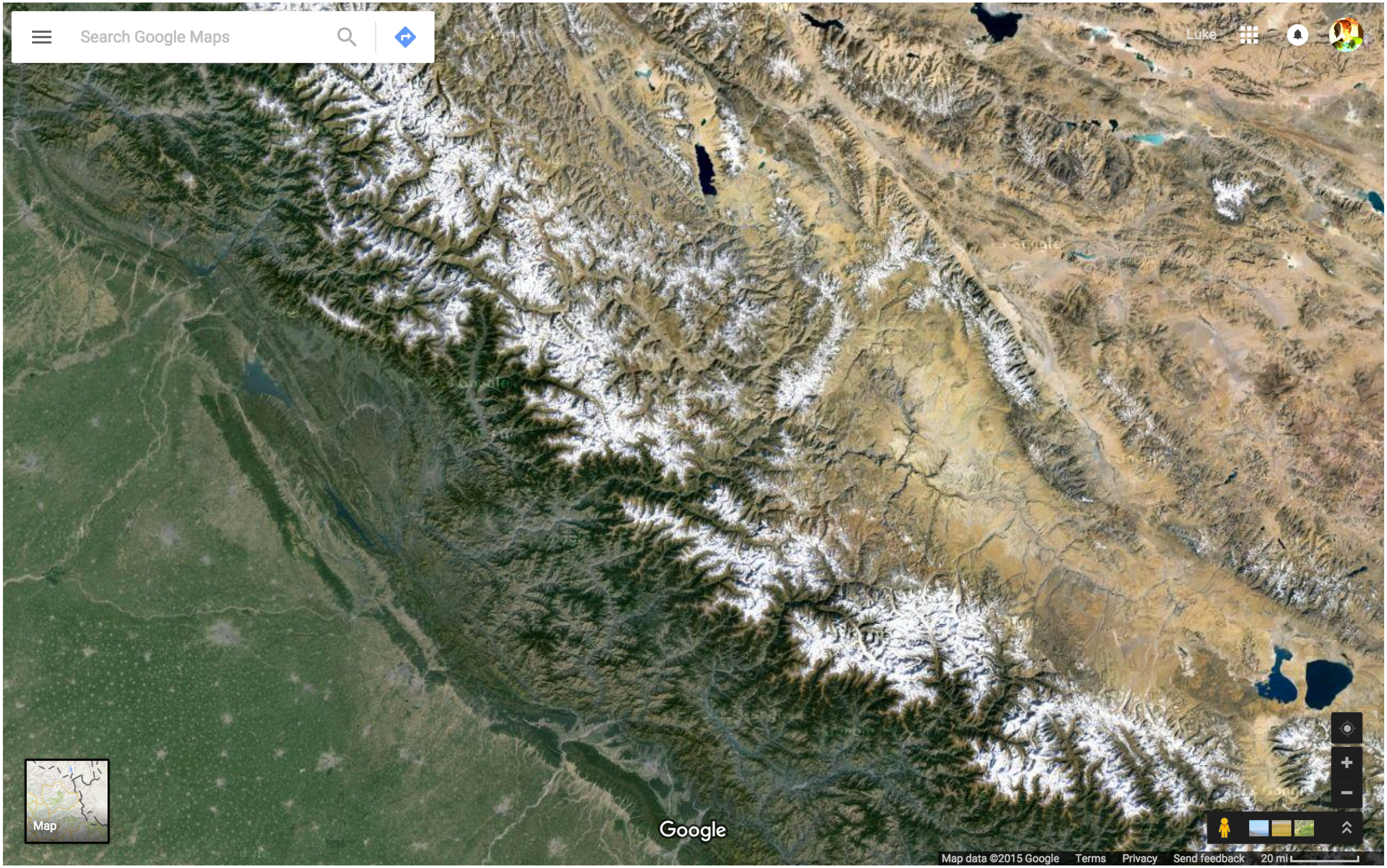
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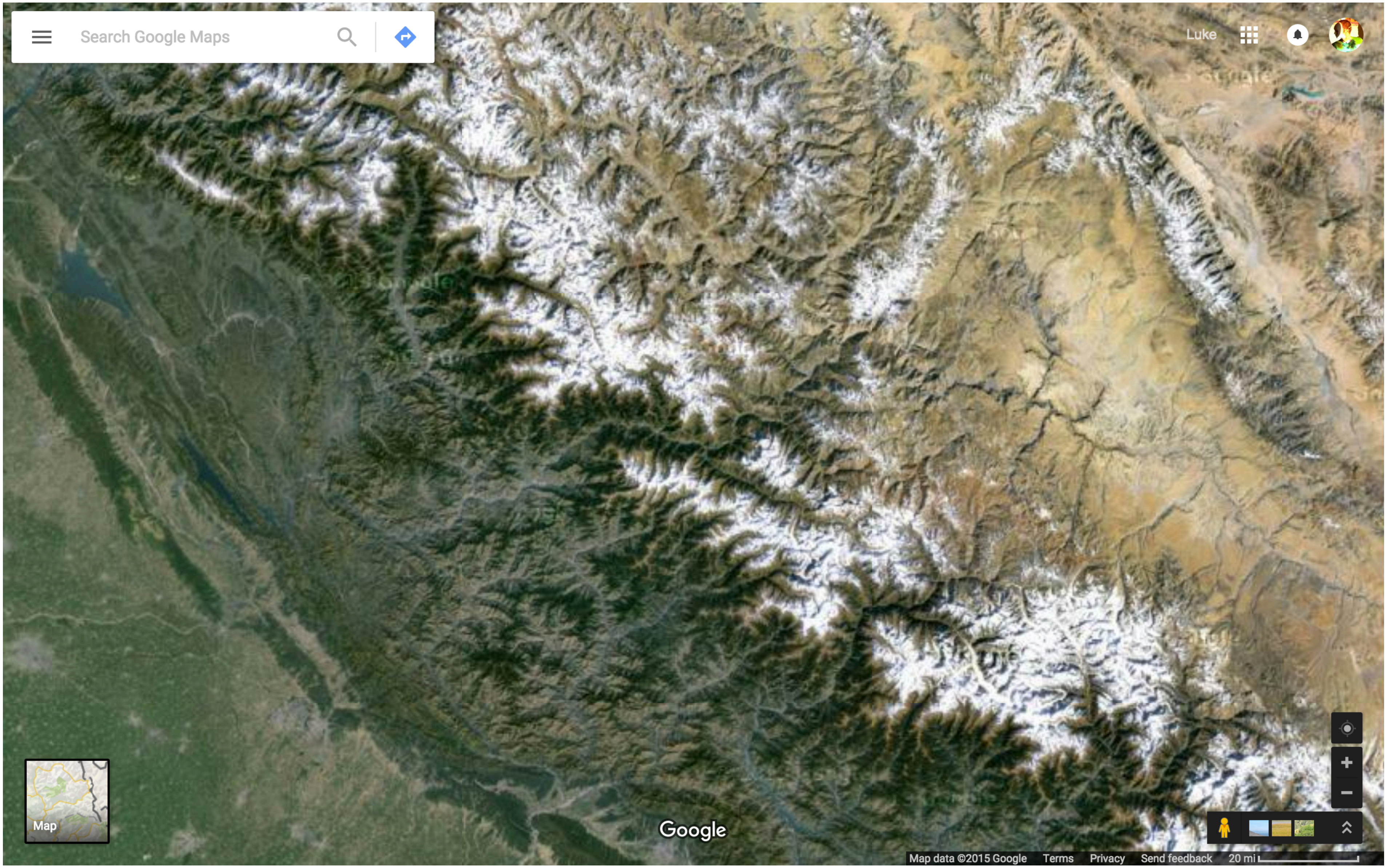

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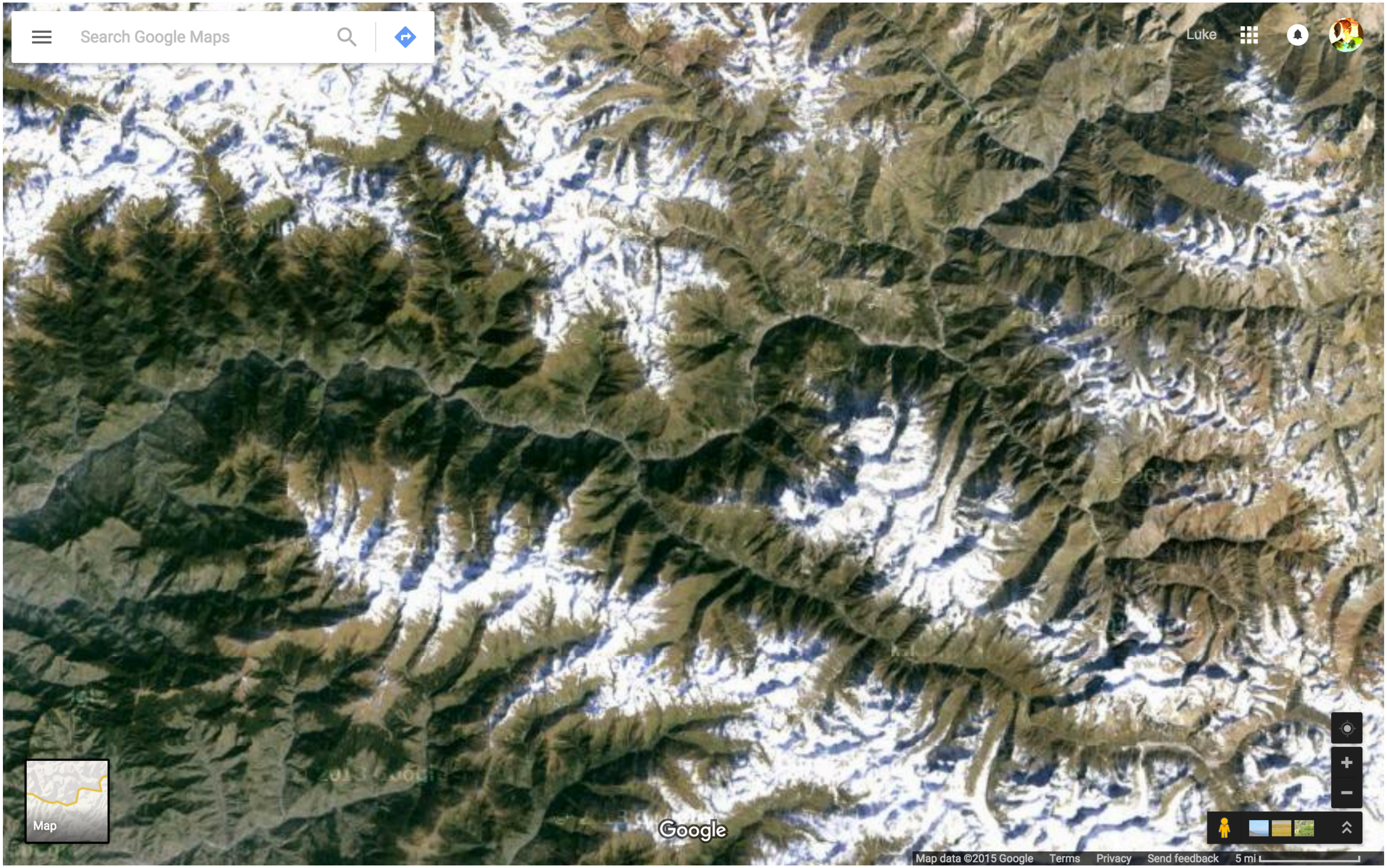
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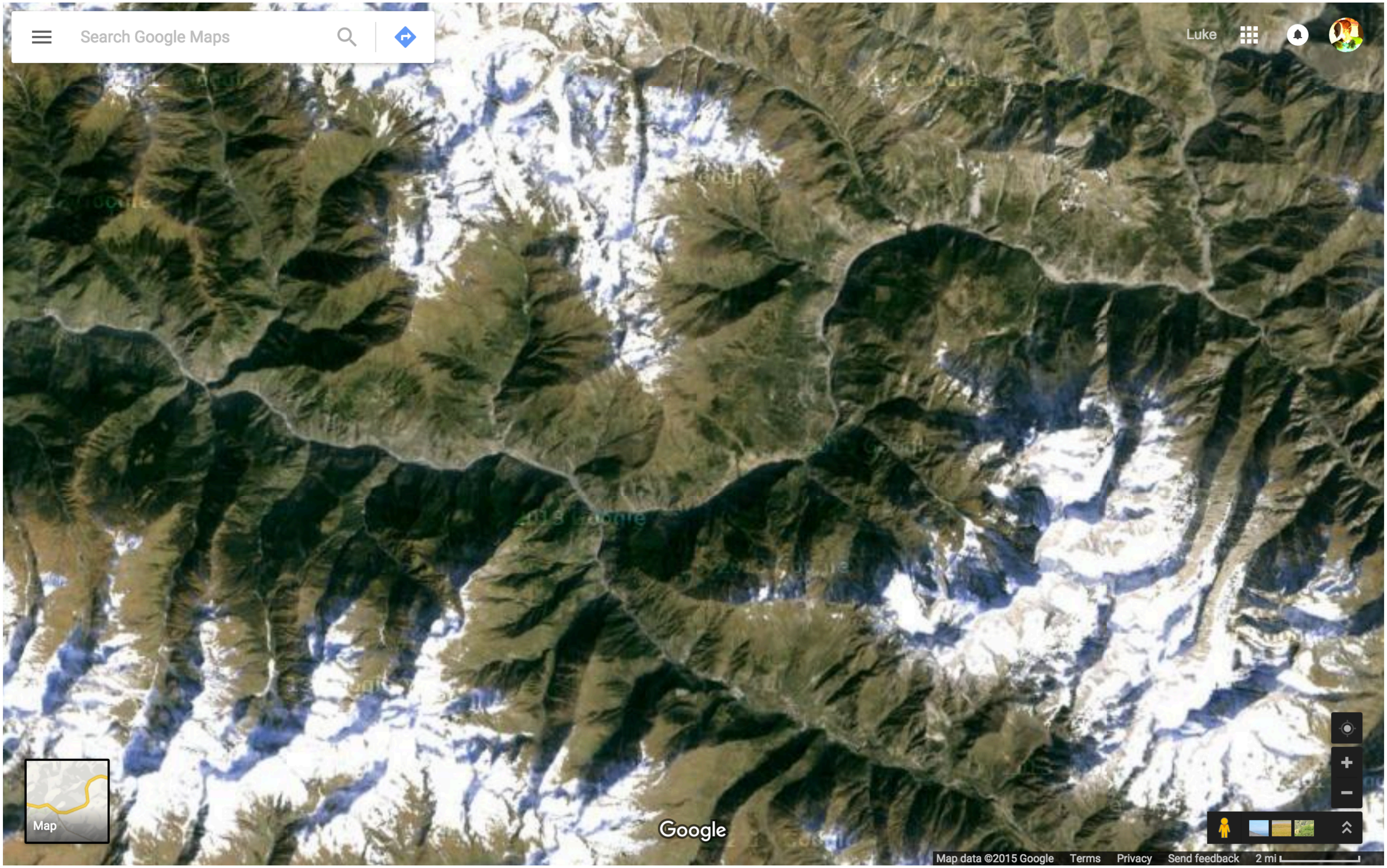
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T in degrees F - boiling point

P in inches Hg - air pressure

H ~~in~~ in feet - height above sea level

$$\boxed{\begin{aligned} T &= a \ln P + b \\ \ln P &= k \ln(c - dH) \end{aligned}}$$

$$P = (c - cdH)^k = c^k(1 - dH)^k$$

$$\frac{T-b}{a} = \ln P \rightarrow P = e^{\frac{T-b}{a}}$$

$$c^k(1-dH)^k = e^{\frac{T-b}{a}}$$

9.6766847708

$a = 49.161$

$b = 44.932$

$c = 1.9091$

$d = 6.8753 \times 10^{-6}$

$k = 5.2559$

$ak = 258.3853$

$$e^{\left(\frac{T-b}{ak}\right)} \frac{1}{c}$$

$$H = \frac{1}{d}\left(1 - \frac{1}{c} e^{\left(\frac{T-b}{ak}\right)}\right)$$

15.C.1. Let G be a group and H a normal subgroup of G. Then $x^2 \in H$ for every $x \in G$ if and only if every element of G/H is its own inverse.

Proof. First we will show that if $x^2 \in H$ for every $x \in G$, then every element of G/H is its own inverse. Let Hx be a generic element of G/H. Then $x \in G$, and by hypothesis, $x^2 \in H$. By Theorem 5 in Chapter 15, this implies that $Hx^2 = He$. Then $Hx^2 = (Hx)(Hx) = He$, by the properties of coset multiplication. Therefore Hx is its own inverse.

To show the converse, we assume that every element of G/H is its own inverse. This implies that for any given $x \in G$, $(Hx)(Hx) = He$, by the definition of inverses. By coset operations, $(Hx)(Hx) = Hx^2 = He$. By Theorem 5 again, $Hx^2 = He$ implies $x^2 \in H$. Thus we have shown that if all elements of G/H are their own inverses, then $x^2 \in H$ for all $x \in G$. □

15.C.3. Let G be a group and H a normal subgroup of G. Then every element of G/H has finite order if and only if for every $x \in G$ there is an integer n such that $x^n \in H$.

Proof. First suppose that for every $x \in G$ there is an integer n such that $x^n \in H$. Let Hx be an arbitrary element of G/H. Let n be such that $x^n \in H$. Then $Hx^n = He$, by Theorem 5 of Chapter 15. But by coset multiplication, $Hx^n = (Hx)^n$. Since He is the neutral element of G/H and $(Hx)^n = He$, the coset Hx has finite order in G/H. Since Hx was arbitrary, every element of G/H has finite order.

Conversely, now assume that every element of G/H has finite order. Then for every $x \in G$, there will be a least positive integer that satisfies $(Hx)^n = He$. Since $(Hx)^n = Hx^n$, this means $Hx^n = He$, so $x^n \in H$ by Theorem 5. Therefore for every $x \in G$, there is an integer n such that $x^n \in H$. □

Theorem 3.5. *Let* T *be a well generated tensor triangulated category such that* $\mathrm{loc}(\mathbb{1}) = \mathsf{T}$, *as in Notation 2.1. Let* $A = \{B_\alpha\}$ *be a (possibly infinite) set of strongly dualizable objects. Then there exists a smashing localization functor* $L : \mathsf{T} \to \mathsf{T}$ *with* $\mathrm{Ker}\, L = \mathrm{loc}(A)$.

Proof. Let $E = \vee_\alpha B_\alpha$ and note that $\mathrm{loc}(E) = \mathrm{loc}(A)$. The category T is well generated by hypothesis. The localizing subcategory $\mathsf{S} = \mathrm{loc}(E)$ is also well generated, by [Iyengar and Krause 2013, Remark 2.2], and is tensor-closed by Lemma 2.5.

By [Iyengar and Krause 2013, Proposition 2.1] there exists a localization functor $L : \mathsf{T} \to \mathsf{T}$ with $\mathrm{Ker}\, L = \mathsf{S}$. We will show that L is a smashing localization.

First we claim that the L-locals are tensor-closed. For any $Y \in \mathsf{T}$, we have

$$\begin{aligned} Y \text{ is } L\text{-local} &\iff [W, Y]_n = 0 \text{ for all } W \in \mathsf{S} \text{ and all } n \in \mathbb{Z} \\ &\iff [E, Y]_n = \prod [B_\alpha, Y]_n = 0 \text{ for all } n \in \mathbb{Z} \\ &\iff [B_\alpha, Y]_n = 0 \text{ for all } \alpha \text{ and } n \in \mathbb{Z} \\ &\iff DB_\alpha \wedge Y = 0 \text{ for all } \alpha. \end{aligned}$$

The second equivalence follows from the fact that $\{X \mid [X, Y]_n = 0 \text{ for all } n \in \mathbb{Z}\}$ is a localizing subcategory containing E, and hence all of S. The final equivalence uses the fact that the B_α are strongly dualizable.

Now suppose Y is L-local and X is arbitrary. Then $DB_\alpha \wedge Y = 0$ for all α, so $DB_\alpha \wedge Y \wedge X = 0$ for all α, and thus $Y \wedge X$ is L-local. This shows that the L-locals are tensor-closed.

Consider the localization triangle $C\mathbb{1} \to \mathbb{1} \to L\mathbb{1}$, where $L\mathbb{1}$ is L-local and $C\mathbb{1} \in \mathsf{S}$. For arbitrary $X \in \mathsf{T}$, tensoring gives an exact triangle,

$$C\mathbb{1} \wedge X \to X \to L\mathbb{1} \wedge X.$$

The object $L\mathbb{1} \wedge X$ is L-local, since the locals are tensor-closed. Likewise, $C\mathbb{1} \wedge X \in \mathsf{S}$, since S is tensor-closed and so $L(C\mathbb{1} \wedge X) = 0$. Therefore $X \to L\mathbb{1} \wedge X$ is an L-equivalence from X to an L-local object, and it follows that $LX \cong L\mathbb{1} \wedge X$. This shows that L is a smashing localization. □


本八合目
御宿 江戸屋


Digi-Sense
MSR
Fuel Bottle
Bouteille de Combustible
Brennstoffflasche

14 August 2015

Roghicliffs @ ~3000m, 12:30pm

temperature : 70.5 °C

$$70.5 \times 9 = 634.5$$

$$634.5 \div 5 = 126.9$$

$$126.9 + 32 = 158.9\ °F \approx T$$

$$H = \frac{1}{d}\left(1 - \frac{1}{c} e^{\left(\frac{T-b}{ak}\right)}\right)$$

$b = 44.932$

$c = 1.9091$

$d = 6.8753 \times 10^{-6}$

$ak = 258.3853$

$$e^{x} = f(0) + \frac{f'(0)}{1!}x + \frac{f''(0)}{2}x^2 + \cdots$$

$$= 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \cdots$$

T − b : 158.9 − 44.9 = 114.0

$\frac{T-b}{ak}$: 258.) 114.0 = 0.4041

$$\begin{array}{r} 1140 \\ -1032 \\ \hline 1080 \\ -1032 \\ \hline \cancel{306} \\ 480 \end{array}$$

should be 0.441

$e^{0.4041}$: x = 0.4041

$$x^2 = 0.4041 \times 0.4041$$

$$\begin{array}{r} 4041 \\ 16164 \\ 161640 \\ \hline \end{array}$$

x^2 : 0.16329681 → $\frac{x^2}{2}$: 0,0816

$$x^3 : 0.16329681 \times 0.4041$$

$$\begin{array}{r} 16329681 \\ 65318724 \\ 00 \\ +65318724 \\ \hline 0.065988240921 \end{array}$$

$6 \,)\, 0.065988240921$

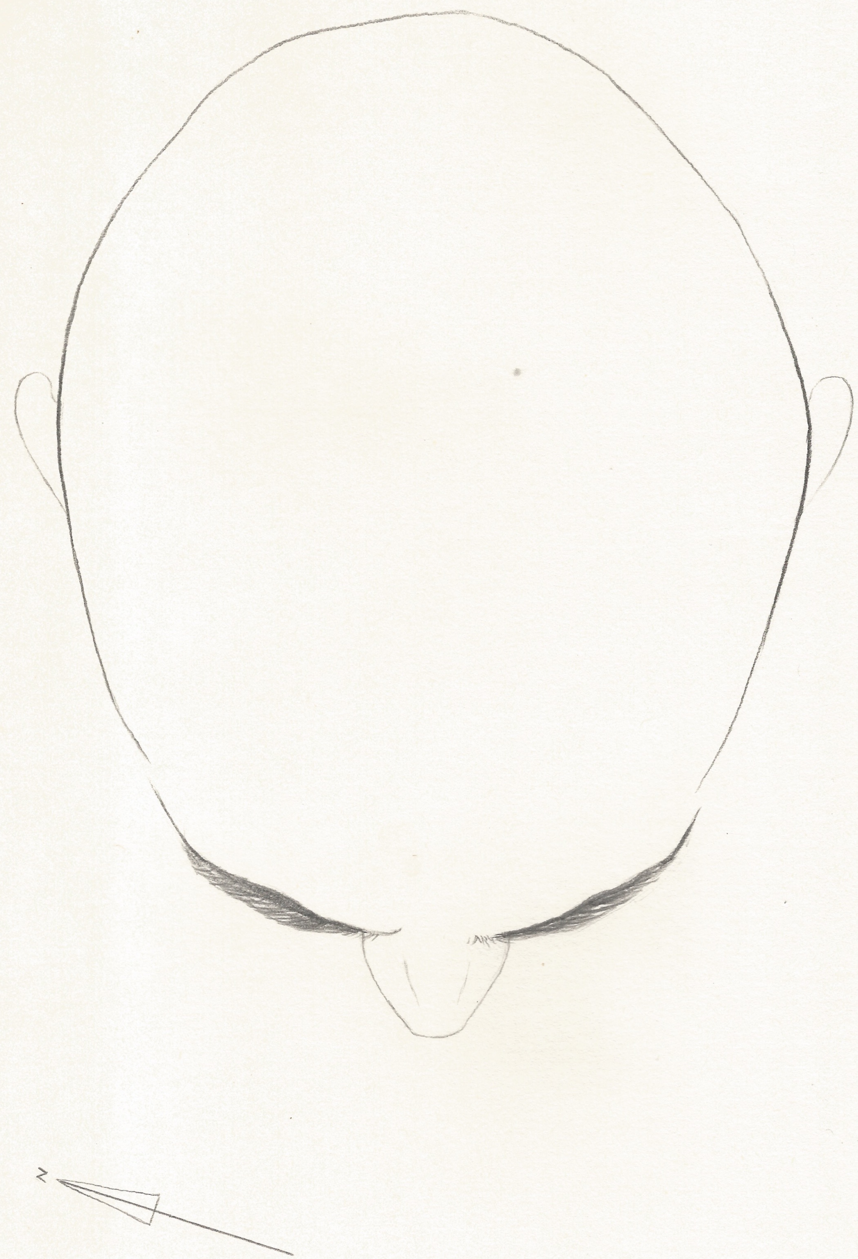
$\cancel{0.02199}$

0.010998

$$1 + x + \frac{x^2}{2} + \frac{x^3}{3} \approx$$

$$\begin{array}{r} 1.0 \\ 0.4041 \\ 0.0816 \\ +0.0101 \\ \hline 1.4958 \end{array}$$

$$\frac{e^{(-)}}{c} :$$



The End.

Thank you to:
Chemistry department for loaning the thermometer
Hitkarsh Chanana '18 for Hindi tutoring