Mathematics, Mathematicians, and Empire

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Land Acknowledgement

> *I work with gratitude on unceded Indigenous lands including those of the Tsleil-Waututh, Kwikwetlem, Squamish and Musqueam nations.*

This nicely introduces the theme of colonization.

God Save the Queen

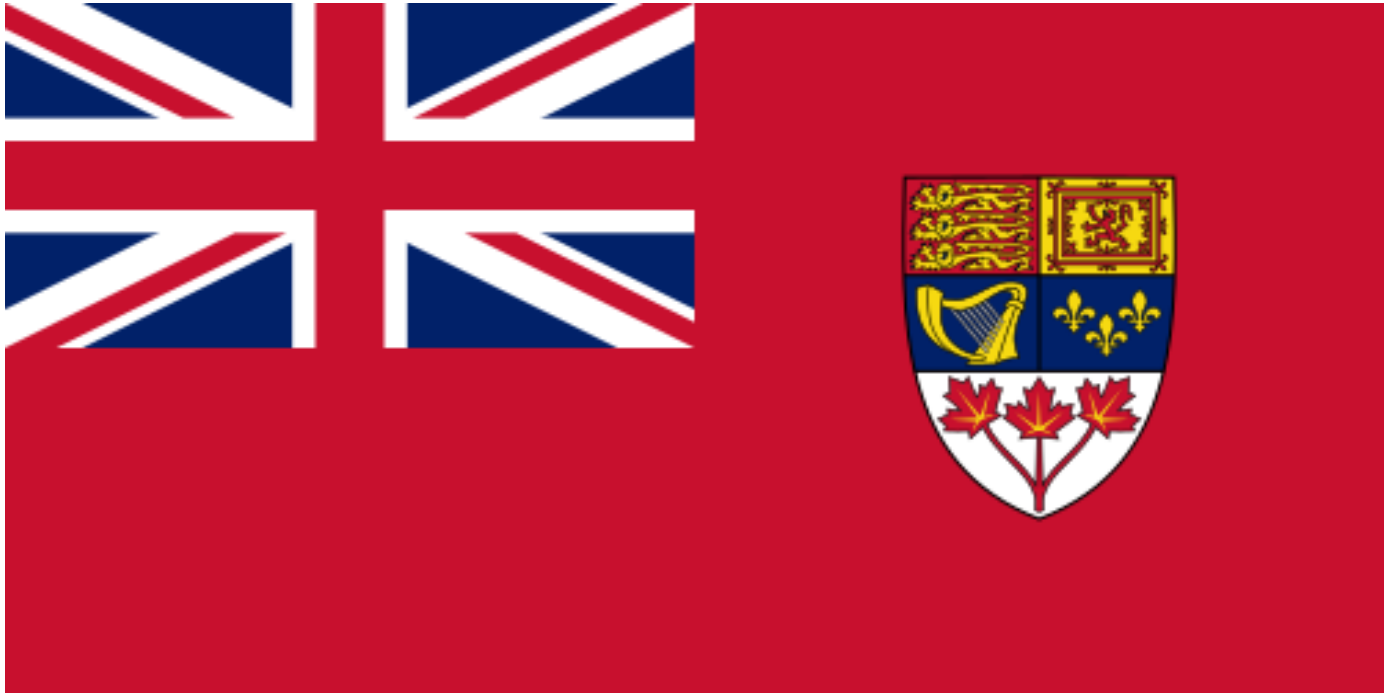


Figure: Flag of the Dominion of Canada until 1965 - All Figures from Wikimedia Commons unless noted

..the sun never sets

Figure: The Pink World

And let's note:

- British Columbia: both Britain and Columbus!
- Victoria
- Vancouver
- Simon Fraser

Migration, colonization, imperialism

- Throughout history, humans have migrated in efforts to improve their living situation.
- This creates tensions in many cases with those already occupying the lands they move to.
- Exploitation, racism, hostility can issue from both sides.
- Colonization is a particular form of migration in which the aim is to establish a group in a new place.
- Imperialism is a state-sponsored acquisition of territories that are to be annexed to the control of the state; and colonization can be an instrument of imperialist policies.
- Example: Sicily (for the ancient Greeks) was a location of colonies, only loosely associated to the mother cities if at all.
- Example: Canada's colonization by France and Britain was undertaken as part of empire-building.

Political Issues concerning Empire: Example

It is beyond doubt, therefore, that capitalism's transition to the stage of monopoly capitalism . . . is connected with the intensification of the struggle for the partitioning of the world. Hobson ... marks the years 1884-1900 as the epoch of intensified "expansion" of the chief European states. – Great Britain during these years acquired 3,700,000 square miles of territory with 57,000,000 inhabitants; France, 3,600,000 square miles with 36,500,000; Germany, 1,000,000 square miles with 14,700,000; Belgium, 900,000 square miles with 30,000,000; Portugal, 800,000 square miles with 9,000,000 inhabitants. .
V. I. Lenin, "Imperialism, the Highest Stage of Capitalism", 1917

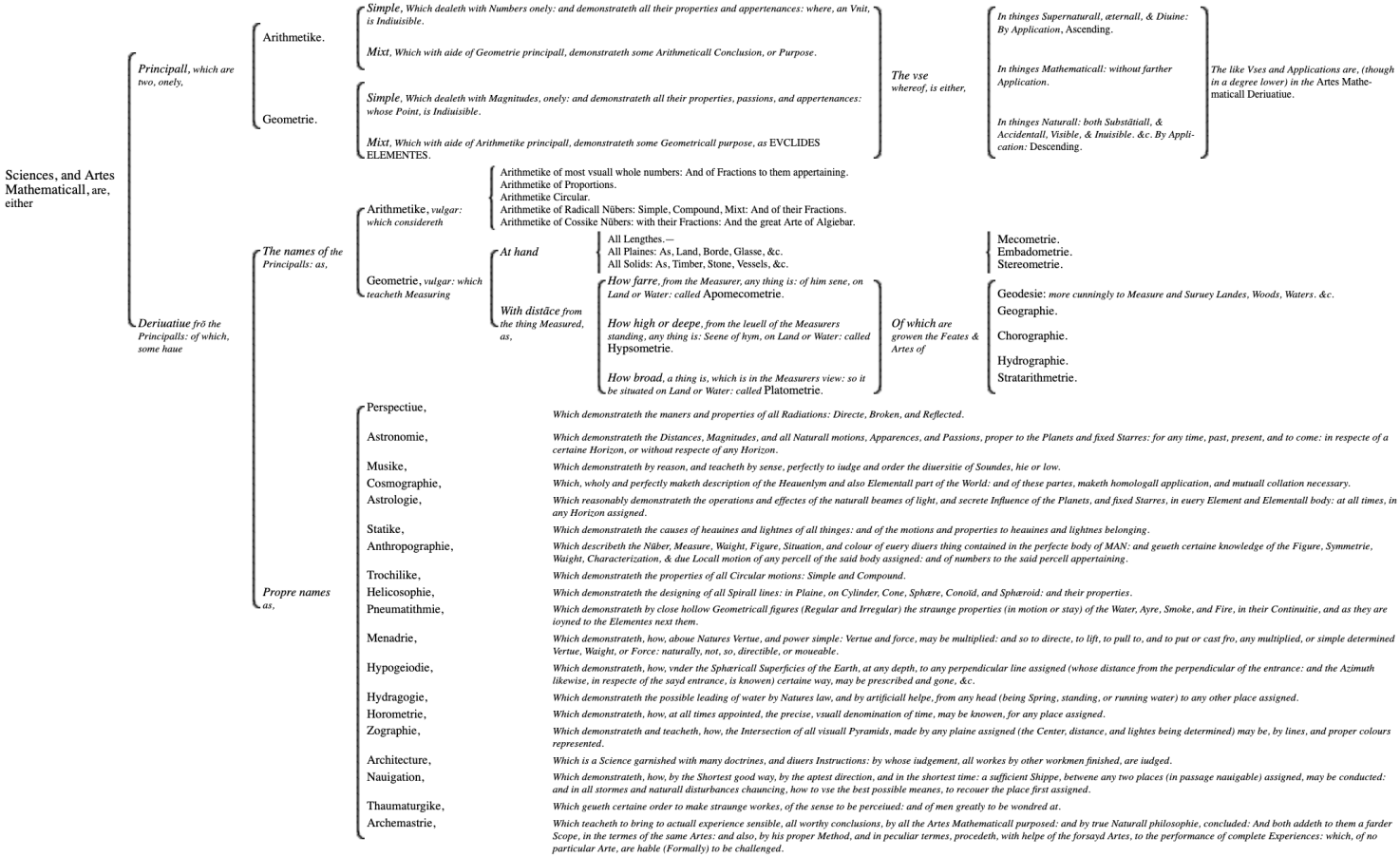
Our talk today

- The involvements of mathematics with colonialism are complex.
- I am not proposing a definitive analysis at all
- We are going to look at some examples through the lens of mathematics and mathematicians.
- Here we will discuss both what mathematics has had to do with empires, and how empires deal with bringing "necessary" mathematics to the colonies, and why.
- I'll concentrate on examples of British imperial expansion in South Asia (India) and in Canada.

Mathematics and Empire

- When research mathematicians think of mathematics, they are usually thinking of the kind of research mathematics that is produced by people like them.
- This is something that took root in the 1800s and grew enormously. This is not our subject today – though of course there is lots of association between higher mathematics and empire.
- Instead we are concerned more with mathematical practitioners, who, since the Early Modern period in Europe (roughly the 15th c. onward) have brought mathematical techniques into contact with civil and military arts.
- These mathematical sciences broadly understood include geodesy/surveying, cartography, gunnery, architecture (fortifications; boats), navigation, astronomy, perspective rendering, statistical tabulation.

Mathematical Sciences: 1570, John Dee



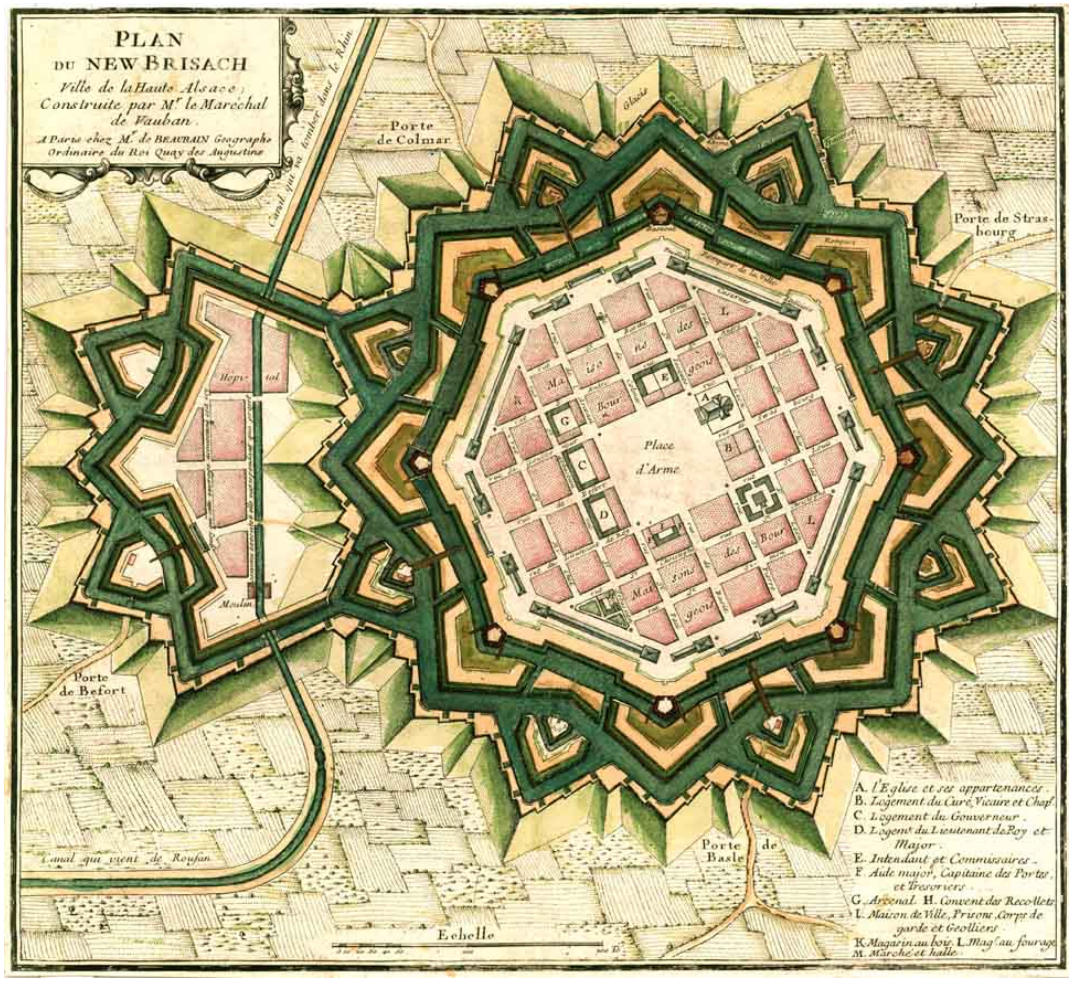
Mathematical Sciences: 1570, John Dee

Perspectiue,	*Which demonstrateth the maners and properties of all Radiations: Directe, Broken, and Reflected.*
Astronomie,	*Which demonstrateth the Distances, Magnitudes, and all Naturall motions, Apparences, and Passions, proper to the Planets and fixed Starres: for any time, past, present, and to come: in respecte of a certaine Horizon, or without respecte of any Horizon.*
Musike,	*Which demonstrateth by reason, and teacheth by sense, perfectly to iudge and order the diuersitie of Soundes, hie or low.*
Cosmographie,	*Which, wholy and perfectly maketh description of the Heauenlym and also Elementall part of the World: and of these partes, maketh homologall application, and mutuall collation necessary.*
Astrologie,	*Which reasonably demonstrateth the operations and effectes of the naturall beames of light, and secrete Influence of the Planets, and fixed Starres, in euery Element and Elementall body: at all times, in any Horizon assigned.*
Statike,	*Which demonstrateth the causes of heauines and lightnes of all thinges: and of the motions and properties to heauines and lightnes belonging.*
Anthropographie,	*Which describeth the Nũber, Measure, Waight, Figure, Situation, and colour of euery diuers thing contained in the perfecte body of MAN: and geueth certaine knowledge of the Figure, Symmetrie, Waight, Characterization, & due Locall motion of any percell of the said body assigned: and of numbers to the said percell appertaining.*
Trochilike,	*Which demonstrateth the properties of all Circular motions: Simple and Compound.*
Helicosophie,	*Which demonstrateth the designing of all Spirall lines: in Plaine, on Cylinder, Cone, Sphære, Conoïd, and Sphæroid: and their properties.*
Pneumatithmie,	*Which demonstrateth by close hollow Geometricall figures (Regular and Irregular) the straunge properties (in motion or stay) of the Water, Ayre, Smoke, and Fire, in their Continuitie, and as they are ioyned to the Elementes next them.*

Military Mathematics

- many (not all) of these categories have military applications.
- I'll concentrate on cartography and navigation (with basically no technical details)
- It's important to note that gunnery was important, with the firing of cannon.
- The parabolic trajectory was argued in the 1500s by Tartaglia, proved by Galileo in 1638.
- The floor plans of forts, and the layout of warships were also key objects of mathematical intervention.

A Vauban fort



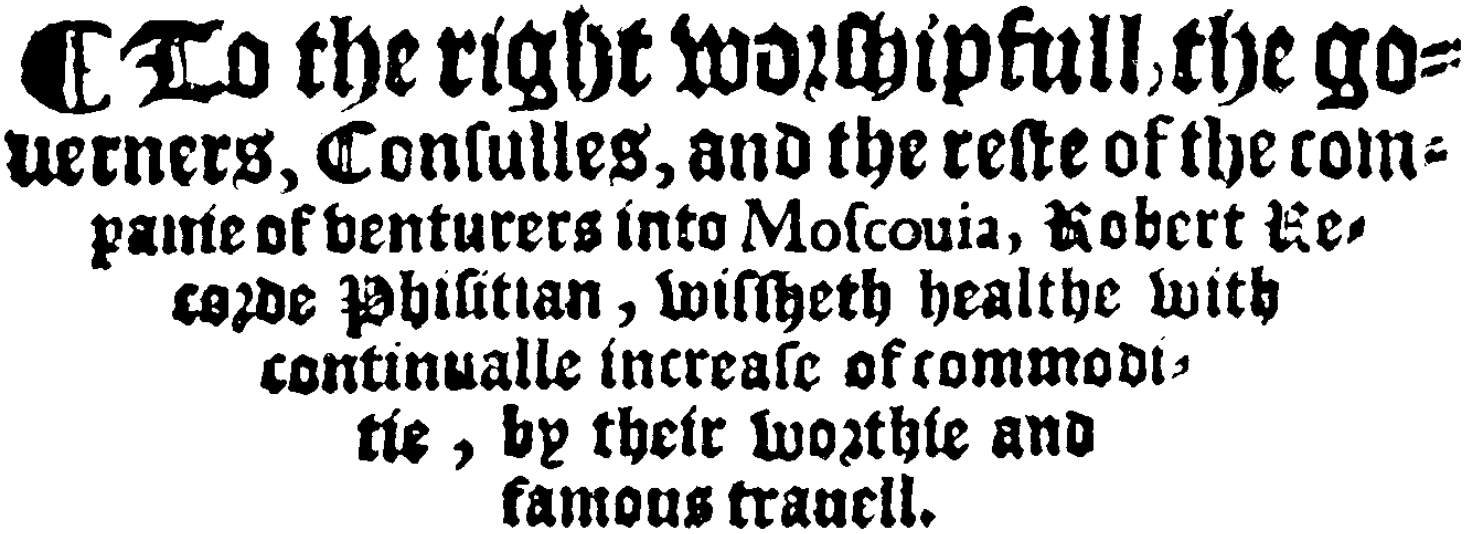
Cannon with a gunner's quadrant, 1558

Renaissance mathematics, Voyages of Trade

- Already in the late 15th c (Columbus, Da Gama) voyages both east and west employed the mathematics of navigation.
- Note that everyone in these fields knew the world was spherical, btw.
- The basic mathematics came from Ptolemy, and the beginning of printing in Europe in the 1450s led to many publications relevant to by the early 1500s. (Ptolemy and simplified versions, etc.)
- Cartography also revived and by 1502 there are western maps that include the East and West Indies, China, Brazil, etc.
- This too was based on Ptolemaic technique but new projections were developed over the 16th c. (Mercator is 1569).

The Cantino Planisphere 1502

Mathematical Sciences: Robert Recorde, England, 1557



¶ To the right worſhipfull, the gouerners, Conſulles, and the reſte of the compaine of venturers into Moſcouia, Robert Recorde Phiſitian, wiſſheth healthe with continualle increaſe of commodi-tie, by their worthie and famous trauell.

Mathematics and the Muscovy Company, 1557

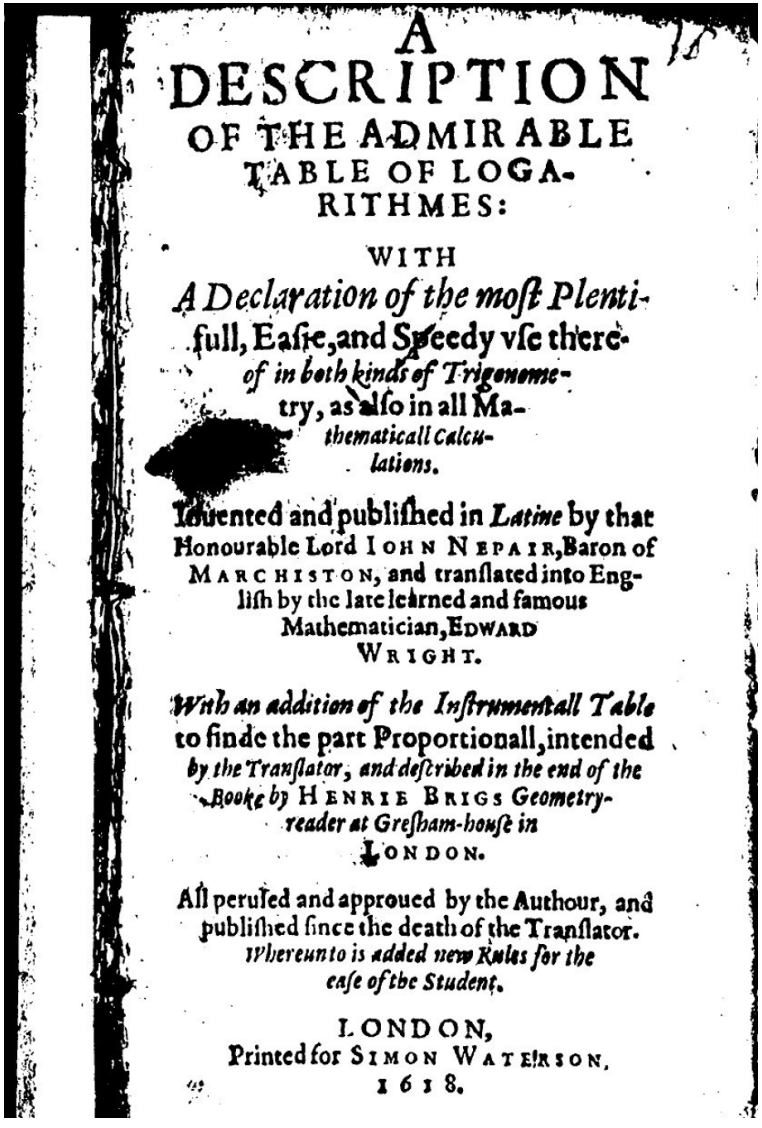
I will for your pleasure, to your comforte, and for your commoditie, shortly set forthe soche a booke of Navigation, as I dare saie, shall partly satisfie and contente, not onely your expectation, but also the desire of a greate nomber beside. Wherein I will not forgett specially to touche, bothe the olde attempte for the Northlie Navigations, and the later good adventure ... So that if you continue with corage, as you have well begon, you shall not onely winne greate riches to your selves, and bryng wonderfull commodities to your countrie ... In that Boke also I will shewe certain meanes, how without greate difficultie, you may saile to the Northe East Indies, And so to Camul, Chinchital, and Balor ...

R. Recorde, Whetstone of Witte, Dedication to the members of the Muscovy Company, 1557

East India Company and Logarithms

- The invention of logarithms in the early 1600s was of immediate interest for the purposes of navigation and cartography.
- Reason: in order to solve basic celestial triangles it was necessary to multiply and divide the 6- and 7- digit numbers involved in trigonometry (the first log tables were logs of sines).
- An early book on this, by Edward Wright, explained this to the practicing navigator.
- The book is dedicated to the East India Company.

Logarithms, 1618



A
DESCRIPTION
OF THE ADMIRABLE
TABLE OF LOGA-
RITHMES:

WITH
A Declaration of the moſt Plenti-
full, Eaſie, and Speedy vſe there-
of in both kinds of Trigonome-
try, as alſo in all Ma-
thematicall Calcu-
lations.

Inuented and publiſhed in *Latine* by that Honourable Lord IOHN NEPAIR, Baron of MARCHISTON, and tranſlated into Engliſh by the late learned and famous Mathematician, EDWARD WRIGHT.

With an addition of the Inſtrumentall Table
to finde the part Proportionall, intended
by the Tranſlator, and deſcribed in the end of the
Booke by HENRIE BRIGS *Geometry-*
reader at Greſham-houſe in
LONDON.

All peruſed and approued by the Authour, and publiſhed ſince the death of the Tranſlator.
Whereunto is added new Rules for the
eaſe of the Student.

LONDON,
Printed for SIMON WATERSON,
1618.

Logarithms and the East India Company, 1618

TO THE RIGHT
HONOVRABLE AND
RIGHT WORSHIPFVLL
COMPANY OF MERCHANTS
of London trading to the East-
Indies, SAMVEL WRIGHT
wisheth all prosperitie in this
life, and happinesse in the
life to come.

Our fauours towards
my deceased Father,
and your imployment
of him in buſineſſe of
this nature, but chiefe-

Log Table, 1618: what is the base?

Deg. 30

m.	Sines	Logarith.	Differen.	Logarit.	Sines	
0	500000	693147	549306	143841	866025	60
1	500252	692643	548634	144009	865880	59
2	500504	692140	547963	144177	865734	58
3	500756	691637	547292	144345	865589	57
4	501007	691134	546621	144514	865443	56
5	501259	690632	545950	144682	865297	55
6	501510	690130	545279	144851	865151	54
7	501762	689628	544609	145019	865005	53
8	502014	689127	543939	145188	864859	52
9	502266	688626	543269	145357	864713	51
10	502517	688125	542599	145526	864567	50
11	502769	687625	541930	145695	864421	49
12	503020	687125	541260	145864	864275	48
13	503271	686625	540591	146034	864128	47
14	503523	686126	539923	146203	863982	46
15	503774	685627	539254	146373	863835	45
16	504025	685128	538586	146543	863689	44
17	504276	684630	537918	146712	863542	43
18	504528	684132	537250	146882	863396	42
19	504779	683635	536582	147052	863249	41

Deg. 30

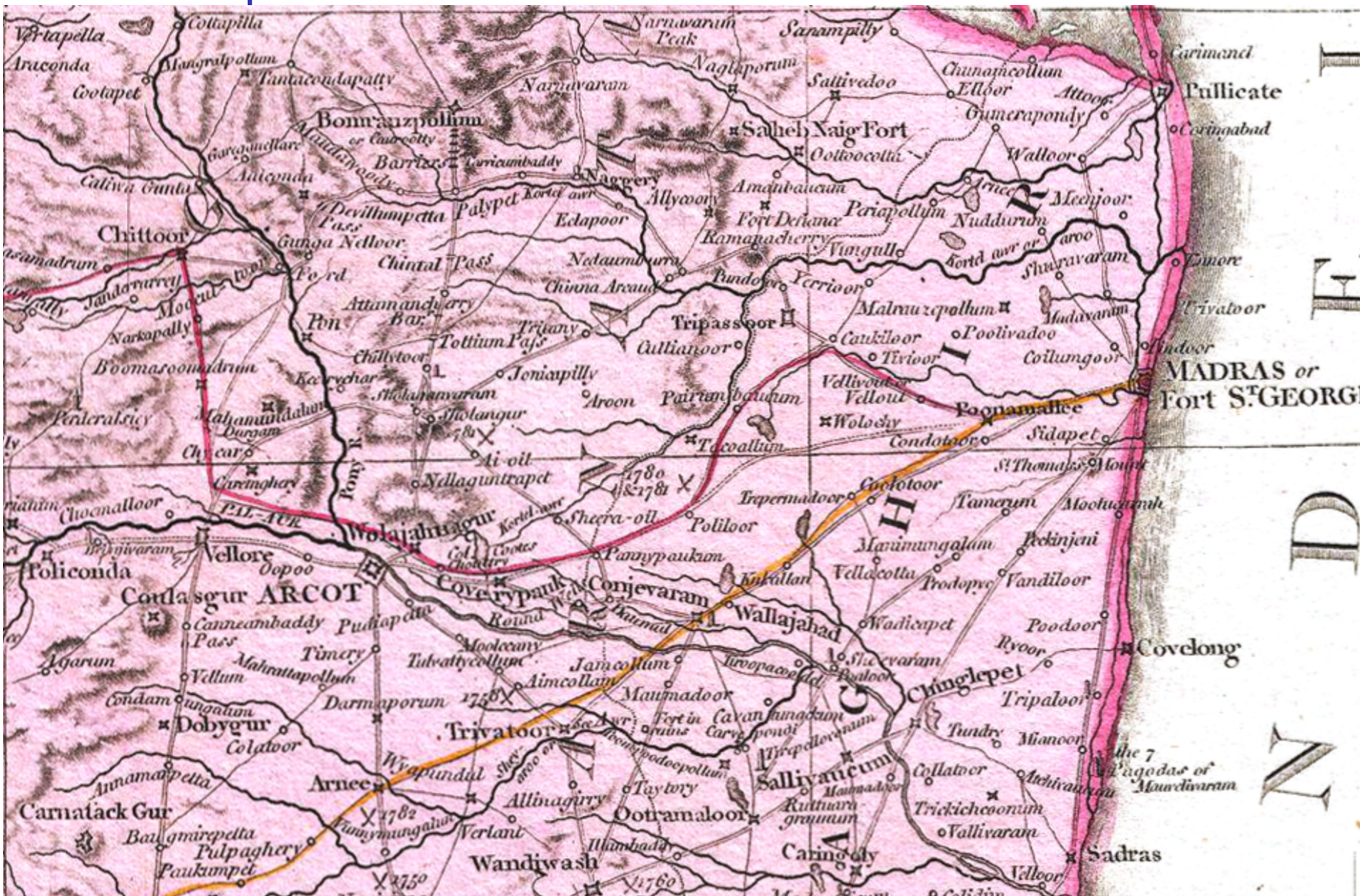
m.	Sines	Logarith.	Differen	Logarit	S
30	507538	678183	529252	148930	8
31	507789	677689	528587	149102	8
32	508040	677196	527922	149273	8
33	508290	676703	527258	149445	8
34	508541	676210	526593	149616	8
35	508791	675717	525929	149788	8
36	509041	675225	525265	149960	8
37	509292	674734	524601	150132	8
38	509542	674242	523938	150305	8
39	509792	673751	523274	150477	8
40	510043	673261	522611	150649	8
41	510293	672770	521948	150822	8
42	510543	672280	521285	150995	8
43	510793	671790	520623	151167	8
44	511043	671301	519961	151340	8
45	511293	670812	519299	151513	8
46	511543	670323	518637	151686	8
47	511793	669835	517977	151860	8
48	512043	669347	517314	152033	8
49	512293	668859	516652	152206	8

- By 150 years later, the East India Company was in charge of large portions of eastern and southern India, and was involved throughout the subcontinent.
- It gradually turned into a government of almost the entire peninsula.
- This lasted until 1858, when failures in its governance let to revolution and necessitated a takeover by the British Crown directly.
- As noted by Lenin, this is the intense period of British colonial expansion.
- It is over the course of the nineteenth century that local governments and local education were largely overtaken in India by British models.

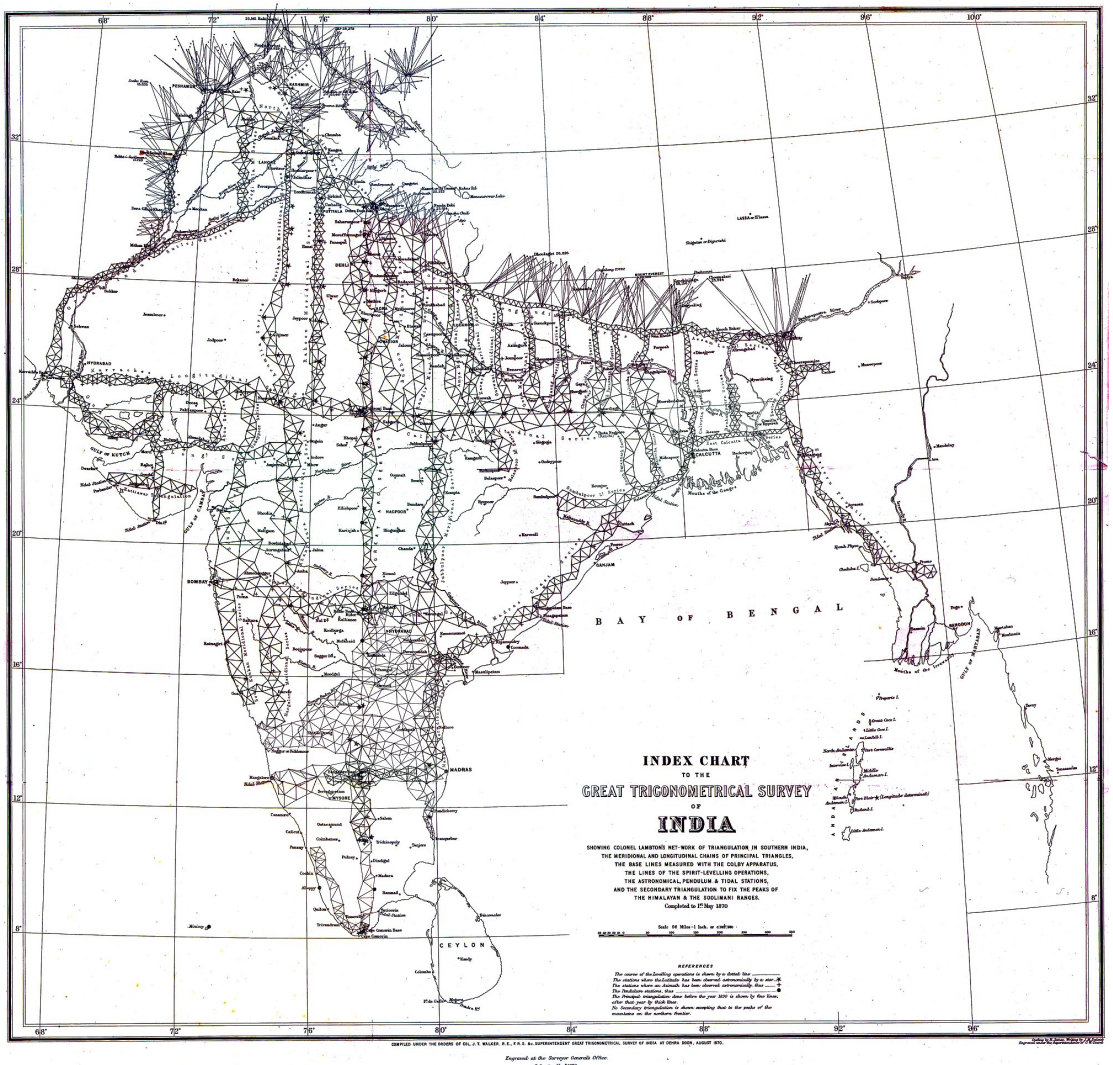
Mathematics of Colonial Administration: Mapping in India

- "India" is a construct of colonial administration.
- Maps are a key tool of states, and especially for empires, and especially for occupying foreign empiires.
- The knowledge of the new territories was normally constructed by maps, as a tool for understanding.
- In India around 1785 the mapping project is aligned with projects to have a kind of census and land registry for the purposes of taxation.
- The first area mapped in detail is the EAC territory: Bengal (James Rennell)

A Rennell map of 1797



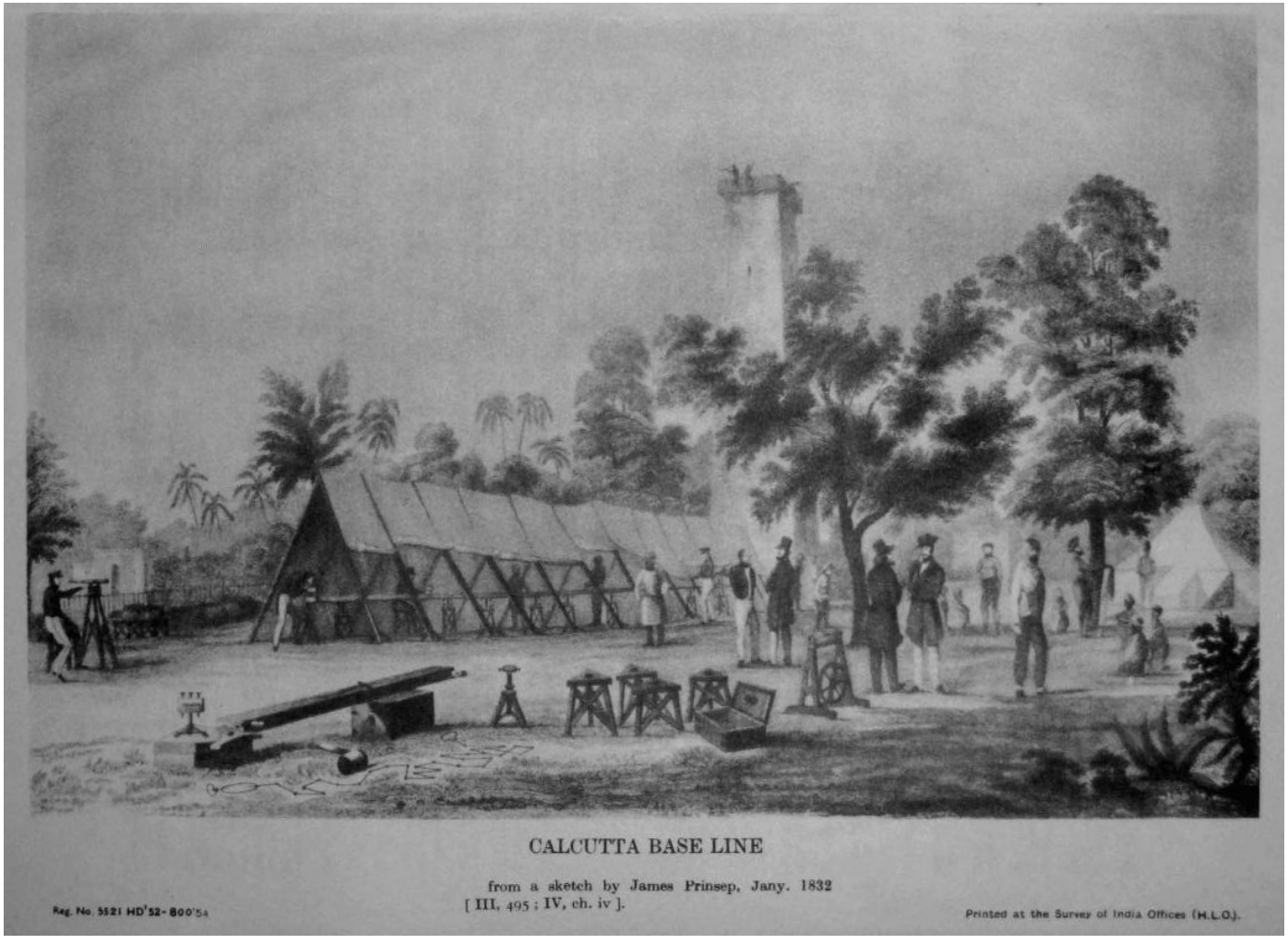
The Great Trigonometrical Survey



The great trigonometrical survey, 1802-1871

- The aim is to produce a precise map of the entire peninsula, using the best contemporary techniques.
- Part of the purpose is to clearly demarcate British (both EAC and Crown) lands from those remaining under various local rulers.
- As it turned out, this was important for the railways also, which began in 1832 in the Madras region to move rock for road construction - soon also passenger rail, beginning in Bombay and Calcutta (EAC centres)
- Led for many years by George Everest, of Mt Everest fame.
- Bosses British (military mostly), much training of locals.

Practical issues: the Calcutta Baseline 1832



The mathematics involved

- Mostly "elementary" - that is, up to trigonometry (incl. spherical)
- However, the instrumentation became quite sophisticated - used for example to determine variations in g.
- In fact, some instruments developed in this context (the Kater pendulum) were groundbreaking.
- instrument design was discussed by some well-known figures (Bessel, Stokes)
- Already in the early 19th c there are local instrument-makers (eg Syed Mohsin near Madras).

Teaching Mathematics in the Colonies

- It is more efficient to train locals than to import all talent from abroad.
- Britain had already begun efforts in England to educate the poor; compulsory education entered by stages of the 19th c.
- The aim was to produce workers suitable for an increasing bureaucracy and for business.
- There is also a "civilizing" component: clean nails and handkerchiefs, proper salutation, workday discipline, loyalty to the nation and Empire.
- These aims were exported to the colonies.

Canada

- In Canada, this followed a pattern that was similar both in French and English Canada.
- At first, all mathematical work – accounts and moneychanging, banking, surveying, navigation, mapmaking – was done by people from the mother country.
- Soon training in place becomes common, at first via apprenticeship, then via schools.
- As in Britain, France, Ireland there is a lot of involvement of religious orders and churches.

Differences between colonies

- However, there were important differences between the colonies.
- Canada, Australia, New Zealand were treated as “empty”; white colonists would become the main population.
- A full education system to serve them was created.
- Indeed, policies that began in North America before US independence accelerated in the 19th c.
- Moving Indigenous people from their lands, exclusion, ethnic cleansing and genocide all occurred.
- The “residential school”, aiming to “destroy the Indian in the child” was part of this.

Universities, Higher Mathematical Training

- Universities and colleges were created throughout the Empire.
- However, far more in the colonies to be taken over by whites (Canada, Australia).
- Initially, lots of the faculty are British: eg McGill 1812, Toronto 1827 - and this continued.
- First Math Head at SFU, Ron Harrap was British (1965), and there were other British imports.
- Originally intended for men principally, though we see women as faculty and students after WWI.
- race-based? well, you had to qualify for admission.
- quotas for Jews at McGill (as in US) - higher averages also! (1924-roughly 1950??)
- but many Canadian schools took (black) students from the Caribbean, Indians in the period after WWII.

Equality of Access?

- To return to residential schools, a few facts about these.
- students separated from their families and homes, punished (beaten) if they spoke their own languages (for example to a sibling)
- based on a US model, intended to be self-supporting through child labour (agriculture, sewing).
- no diplomas, hence no qualification for higher education.
- already in place before Confederation, institutionalized gradually along with reservation system (1916).
- part of general attempt at destruction of Indigenous culture, eg banning of potlach
- ended in ... 1990s!!

Relation to colonialism?

- The colonial administrators are the ones who instituted and maintained these racist programs of destruction.
- For example Edward Cornwallis, military governor of Nova Scotia, offered a bounty for Miqmaw scalps in the 1740s
- his brother was the Archbishop of Canterbury.
- His nephew, Charles Cornwallis, fought against US independence, was governor-general of India, and fought against Tipu Sultan in Mysore.

It is precisely because education was the primary tool of oppression of Aboriginal people, and miseducation of all Canadians, that we have concluded that education holds the key to reconciliation.
Murray Sinclair, 2014

Theoretical Framework: Knowledge is Power, or Power is Knowledge

the theorists of a relationship between knowledge and power would posit a causal relationship in one or the other direction:

- *either a change in the form and manner in which power was exercised would cause a corresponding shift in the nature of the knowledge thereby produced,*
- *or the shift in forms of knowledge would precede and somehow facilitate the exercise of power.*

There is much analysis on this: Example

Where the colonial relationship is concerned, historians have tended to favour the former version, seeing colonial conquest as producing a series of institutions (surveys, censuses, the colonial police, and so on) that determine the nature of colonial knowledge.
It is of course possible to argue that a long-term stability exists in the terms of the production of European knowledge on India, going back at least to the medieval period; this would be a sort of "European essence" in terms of the will-to-knowledge, which suffers only minor modifications with the move from a situation of relative political parity in, say, 1700, to one of a rather unequal relationship a century later.
Sanjay Subrahmanyam, "Europe's India"

Some Relevant References

- Archibald, T. and V. Jungič "Mathematics and First Nations in Western Canada: From Cultural Destruction to a Re-Awakening of Mathematical Reflections", in *Mathematical Cultures*, ed. B. Larvor, Boston: Birkhäuser, 2016.
- Edney, Matthew H. *Mapping an Empire: the Geographical Construction of British India, 1765-1843*. Chicago: University of Chicago Press, 1997.
- Sinclair, Murray, "Overcoming History: Education, cause and solution". *The Manitoba Teacher*, 93, Dec. 2014.
- Subrahmanyam, Sanjay. *Europe's India: Words, People, Empires, 1500-1800*. Cambridge, MA: Harvard University Press, 2017.