SI649 / EECS 548 Individual Project, Winter 2023

The individual project for this course is about making communicative visualizations to add detail, context, and nuance to a news article. The article we have selected for this year is about disability and access to healthcare. It includes lots of specific claims based on data, and links to several scientific studies, but does not make use of any data visualization. (A few of the linked studies have been uploaded to canvas as a starting point, but please do not limit yourselves to these).

Your goal in this project is to design and create visualizations to accompany the story, in a way that would benefit the reader. In particular, we will eventually ask you to create one static and one interactive visualization. These could be *in-line* visualizations, to directly accompany parts of the article (between paragraphs, for example), and/or *sidebar* visualizations (see <u>in-line vs sidebar</u> below), which are almost like miniature articles embedded within the larger article. You are free to focus on any aspect of this article you like, including regional, national, individual, or other factors, in order to provide greater detail and context. In other words, *don't limit yourself to the specific statistics or studies quoted in the article*.

This project will have two phases:

- In the first phase, you will locate and explore the data related to this article, and think about what sorts of visualizations you want to create for this story. You will then submit a set of sketches, which express the core elements of your proposed designs, without necessarily utilizing any actual data. For sketches of interactive or animated visualizations, briefly describe how they would function.
- For the second phase, you will create two visualizations for submission. The final submission will include both the visualizations themselves, as well as a short report explaining your design decisions and processes.

Article

The story we are basing this project on is called "Doctors Are Failing Patients With Disabilities", by Emma Yasinski, published in the The Atlantic on November 13, 2022 (originally published in Undark Magazine). You can find a copy in the files on Canvas, or (if you have subscriber access), you can read it online here: <u>https://www.theatlantic.com/health/archive/2022/11/disability-health-care-accessibility-doctors-ada/672101/</u>

Deliverables

1. Initial design sketches:
    - After reading the article and locating data, do some brainstorming as to what sorts of visualizations (static or interactive) you might like to make to accompany this story. Create a mockup of four ideas (either hand drawn or made using software of your choice). These mockups do not need to be based on the actual data, but should give the reader a clear sense of what it is you plan to visualize. For each one, include a few sentences to explain what the visualization is, and what it is intended to communicate. You should submit the mockup and description for three ideas (as a pdf) by the end of Sunday February 12th.
2. Final visualization:
    - For the final submission, create your final, high-quality visualizations (one static and one interactive) to accompany the article. The key question is how well your visualizations complement and augment of the article. You are free to implement your visualizations in any way you choose. Static visualizations should be submitted as pdfs. Interactive visualizations should ideally be hosted online where we can access them (just submit the url and a screenshot as a pdf), or else submitted with clear instructions as to how we can run them (without any special effort), ideally using some combination of Tableau, Altair, Streamlit, and/or Jupyter. You should submit these by the end of Sunday March 12th.
3. Final report (written as a short, informal blog post)
    - In addition, to accompany your final submission, you should write a short informal report, (something like a blog post), that describes your process (due on the same day as the final visualizations). This report should cover:
        - **Learning objectives**: What do you want the viewer to take away from your visualization(s)? What will they learn and remember from it? You may want to refer to http://visualobjectives.net/ for help in designing these.
        - **Your design process**: What did you try? (feel free to include screenshots). What examples did you look at for inspiration? (again, screenshots are welcome). The expectation is that you tried multiple things and iterated over your design over the several weeks of this project. Describe what you liked or didn't like about your initial design, and how you arrived at your final implementation.
        - **Qualitative self-evaluation**: How would you judge your own design and creation? In what ways is it effective? How could it be improved? Please connect this to principles that you have learned in class.

- Here is an example of a process blog that you may want to refer to as loose inspiration (but please follow the format outlined above, not the format used by this example, and try to be concise): https://www.visualcinnamon.com/2019/04/designing-google-cats-and-dogs/

Evaluation Criteria

For the final submission, we will be looking at:

1. Relevance to the article: Would your visualizations fit naturally as part of the article
2. Insights: how much do these visualizations add to the reader's understanding?
3. Clarity, effectiveness, and functionality: how effective are your visualizations, and how well does the interactive one work in terms of functionality?
4. Aesthetics: Have you used good design principles and considered human perception and cognitive limitations in designing your visualizations?
5. Creativity and effort: How interesting or ambitious are your visualizations? Do they reflect a considerable amount of effort?
6. Writing: how well written is the report?

Analysis vs Exploration

As you approach this project, try to put yourself in the role of a data journalist. That is, you are both an analyst and a communicator. As an analyst, it's up to you to find interesting things in the data (some of which are suggested by the article content), but you should also think critically about the data and analyze it in a rigorous way. Visualization may be an effective tool in exploring and analyzing the data, but these are not likely to be the visualizations you will submit as your final work (except as screenshots of your process in the blog post). Rather, you should design and create self-contained visualizations (possibly with short accompanying textual descriptions) that will help the reader achieve the learning objectives you define. Thus, in your role as a communicator, you need to put yourself in the mindset of the reader, recognize that they haven't gone through the same work of exploration and analysis that you have, and find a way to effectively communicate the information you want to get across just based on the final visualizations you create.

Aesthetics

Keep in mind that the final results should have both function and form. That means the visualization should *look* good in the end. You are welcome to use any software you like to augment or touch up your static visualization (e.g., Illustrator, Figma, Inkscape, or even Powerpoint). Just make sure to describe your process in your report.

If you are creating an infographic style layout, you should consider where you place things, how they connect, etc. If you are confused about this, take a look at the Makeover Monday community. They used to take "bad" visualizations and infographics and propose various improvements.

Datasets

To get you started, we have included a few of the linked scientific studies, which contain some tabular data in their pdfs.

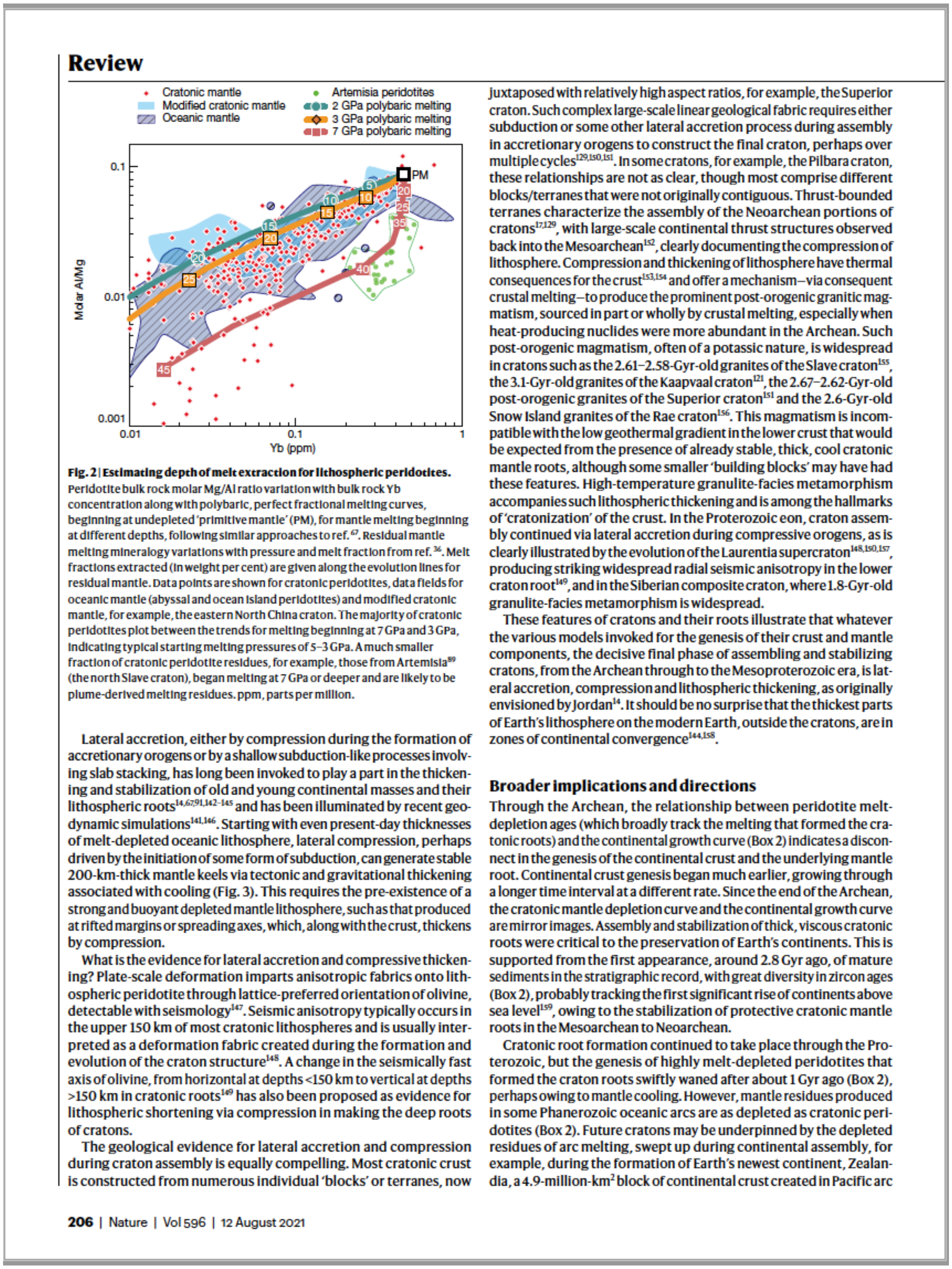
In addition, we encourage you to look for additional data relevant to the topic, including in other linked studies and external resources. (Just to make sure to document where you got it from).

Here are some sources you might want to look into (with many more to be found online):

- CDC data: https://www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html#:~:text=61%20million%20adults%20in%20the,have%20some%20type%20of%20disability (Note the References at the bottom, which link to two additional resources with lots of data)
- US Census data tables: https://www.census.gov/topics/health/disability/data/tables.html
- Association of Health Care Journalists Disability resources: https://healthjournalism.org/core-topic.php?id=4&page=data#Disability
- ProPublica guide to disability data: https://ncdj.org/wp-content/uploads/2021/12/disab_data_lafleur.pdf
- Disability on Data.world https://data.world/datasets/disability

In-line vs Sidebar

Below, you can see the difference between an in-line image (first) and a sidebar (second). A sidebar is a “mini” article. Both are acceptable and may have different uses.



Review

Fig. 2 | Estimating depth of melt extraction for lithospheric peridotites. Peridotite bulk rock molar Mg/Al ratio variation with bulk rock Yb concentration along with polybaric, perfect fractional melting curves, beginning at undepleted ‘primitive mantle’ (PM), for mantle melting beginning at different depths, following similar approaches to ref. [67]. Residual mantle melting mineralogy variations with pressure and melt fraction from ref. [36]. Melt fractions extracted (in weight per cent) are given along the evolution lines for residual mantle. Data points are shown for cratonic peridotites, data fields for oceanic mantle (abyssal and ocean island peridotites) and modified cratonic mantle, for example, the eastern North China craton. The majority of cratonic peridotites plot between the trends for melting beginning at 7 GPa and 3 GPa, indicating typical starting melting pressures of 5–3 GPa. A much smaller fraction of cratonic peridotite residues, for example, those from Artemisia[89] (the north Slave craton), began melting at 7 GPa or deeper and are likely to be plume-derived melting residues. ppm, parts per million.

Lateral accretion, either by compression during the formation of accretionary orogens or by a shallow subduction-like processes involving slab stacking, has long been invoked to play a part in the thickening and stabilization of old and young continental masses and their lithospheric roots[14,67,91,142–145] and has been illuminated by recent geodynamic simulations[141,146]. Starting with even present-day thicknesses of melt-depleted oceanic lithosphere, lateral compression, perhaps driven by the initiation of some form of subduction, can generate stable 200-km-thick mantle keels via tectonic and gravitational thickening associated with cooling (Fig. 3). This requires the pre-existence of a strong and buoyant depleted mantle lithosphere, such as that produced at rifted margins or spreading axes, which, along with the crust, thickens by compression.

What is the evidence for lateral accretion and compressive thickening? Plate-scale deformation imparts anisotropic fabrics onto lithospheric peridotite through lattice-preferred orientation of olivine, detectable with seismology[147]. Seismic anisotropy typically occurs in the upper 150 km of most cratonic lithospheres and is usually interpreted as a deformation fabric created during the formation and evolution of the craton structure[148]. A change in the seismically fast axis of olivine, from horizontal at depths <150 km to vertical at depths >150 km in cratonic roots[149] has also been proposed as evidence for lithospheric shortening via compression in making the deep roots of cratons.

The geological evidence for lateral accretion and compression during craton assembly is equally compelling. Most cratonic crust is constructed from numerous individual ‘blocks’ or terranes, now juxtaposed with relatively high aspect ratios, for example, the Superior craton. Such complex large-scale linear geological fabric requires either subduction or some other lateral accretion process during assembly in accretionary orogens to construct the final craton, perhaps over multiple cycles[129,150,151]. In some cratons, for example, the Pilbara craton, these relationships are not as clear, though most comprise different blocks/terranes that were not originally contiguous. Thrust-bounded terranes characterize the assembly of the Neoarchean portions of cratons[17,129], with large-scale continental thrust structures observed back into the Mesoarchean[152], clearly documenting the compression of lithosphere. Compression and thickening of lithosphere have thermal consequences for the crust[153,154] and offer a mechanism—via consequent crustal melting—to produce the prominent post-orogenic granitic magmatism, sourced in part or wholly by crustal melting, especially when heat-producing nuclides were more abundant in the Archean. Such post-orogenic magmatism, often of a potassic nature, is widespread in cratons such as the 2.61–2.58-Gyr-old granites of the Slave craton[155], the 3.1-Gyr-old granites of the Kaapvaal craton[121], the 2.67–2.62-Gyr-old post-orogenic granites of the Superior craton[151] and the 2.6-Gyr-old Snow Island granites of the Rae craton[156]. This magmatism is incompatible with the low geothermal gradient in the lower crust that would be expected from the presence of already stable, thick, cool cratonic mantle roots, although some smaller ‘building blocks’ may have had these features. High-temperature granulite-facies metamorphism accompanies such lithospheric thickening and is among the hallmarks of ‘cratonization’ of the crust. In the Proterozoic eon, craton assembly continued via lateral accretion during compressive orogens, as is clearly illustrated by the evolution of the Laurentia supercraton[148,150,157], producing striking widespread radial seismic anisotropy in the lower craton root[149], and in the Siberian composite craton, where 1.8-Gyr-old granulite-facies metamorphism is widespread.

These features of cratons and their roots illustrate that whatever the various models invoked for the genesis of their crust and mantle components, the decisive final phase of assembling and stabilizing cratons, from the Archean through to the Mesoproterozoic era, is lateral accretion, compression and lithospheric thickening, as originally envisioned by Jordan[14]. It should be no surprise that the thickest parts of Earth’s lithosphere on the modern Earth, outside the cratons, are in zones of continental convergence[144,158].

Broader implications and directions

Through the Archean, the relationship between peridotite melt-depletion ages (which broadly track the melting that formed the cratonic roots) and the continental growth curve (Box 2) indicates a disconnect in the genesis of the continental crust and the underlying mantle root. Continental crust genesis began much earlier, growing through a longer time interval at a different rate. Since the end of the Archean, the cratonic mantle depletion curve and the continental growth curve are mirror images. Assembly and stabilization of thick, viscous cratonic roots were critical to the preservation of Earth’s continents. This is supported from the first appearance, around 2.8 Gyr ago, of mature sediments in the stratigraphic record, with great diversity in zircon ages (Box 2), probably tracking the first significant rise of continents above sea level[159], owing to the stabilization of protective cratonic mantle roots in the Mesoarchean to Neoarchean.

Cratonic root formation continued to take place through the Proterozoic, but the genesis of highly melt-depleted peridotites that formed the craton roots swiftly waned after about 1 Gyr ago (Box 2), perhaps owing to mantle cooling. However, mantle residues produced in some Phanerozoic oceanic arcs are as depleted as cratonic peridotites (Box 2). Future cratons may be underpinned by the depleted residues of arc melting, swept up during continental assembly, for example, during the formation of Earth’s newest continent, Zealandia, a 4.9-million-km^2 block of continental crust created in Pacific arc

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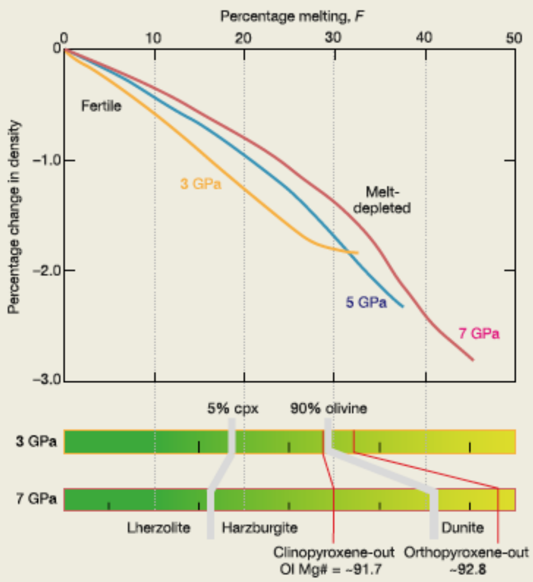
Box 3

Mantle peridotite density and mineralogy as a function of melt depletion

The process of partial melting acting on mantle peridotite removes elements that prefer the melt phase relative to the solid phase, notably Ca and Al, concentrating others that prefer the solid phase, such as Mg. This leads to systematic changes in the nature of the peridotite with extent of melt removal, transforming an un-melted or "fertile" peridotite into a residual or "depleted" peridotite, accompanied by changes in lithology, mineralogy, mineral chemistry and density (see Box 3 figure).



Box 3 figure | Variation in mantle peridotite density, mineralogy, olivine chemistry and lithology as a function of extent of partial melting. Bulk density variation, given as relative percentage change from a fertile (un-melted) mantle peridotite (lherzolite) as a function of fraction of melt extracted, for polybaric perfect fractional melting of three different pressures of melt initiation: 3 GPa, 5 GPa and 7 GPa, following ref. [33]. Green horizontal bars show the variation in residual (melt-depleted) peridotite mineralogy (for pyroxenes and olivine normalized to 100%) and hence lithological change, as extracted melt fraction increases. The most residual (melt-depleted) mantle peridotite is a dunite. cpx, clinopyroxene; opx, orthopyroxene.

craton) is underlain by deep lithospheric mantle of Archean age[115], and a similar age relationship exists in East[48] and West[116] Greenland, part of the Laurentia supercraton (Fig. 1).

Some Palaeoproterozoic cratonic peridotites have highly depleted major-element and mineral compositions resembling those formed in the Archean, for example, in Arctic Canada[113] (Box 1 figure a). This and other examples[58,67,91,127] indicate that very depleted melt residues can be produced well beyond the Archean/Proterozoic boundary, in contrast to some proposals[55,128]. Such highly depleted Palaeoproterozoic lithospheric mantle became incorporated into craton roots during major post-Archean craton-forming accretionary orogens[129].

The variation in peridotite compositions—and hence melting conditions—with geological time is of interest in understanding the origins of cratonic peridotites as well as mantle thermal evolution[70,80,130]. A recent approach[70], augmented here using the most reliable estimates of melting ages for peridotite suites screened via criteria such as extended platinum group element (PGE) patterns[81,103] (Box 2 figure b) indicates that the apparent secular decrease in peridotite olivine Mg# with decreasing model age (excluding Phanerozoic arc peridotites) fits well with the expected trend of secular decrease in mantle potential temperature, at Urey ratios of between 0.2 and 0.3. This fit, though imperfect, suggests that no anomalously hot mantle plume is required to explain the melting regime of cratonic peridotite residues, consistent with an origin via relatively shallow decompression melting[70].

The importance of lateral accretion in the formation of cratons and cratonic mantle

In the context of craton formation, the debate over the relative roles of residual peridotites formed by mantle plume melting versus those formed by the thickening of residues of shallow polybaric decompression melting can be addressed through geodynamic modelling. Mantle lithosphere above modern mantle plumes experiences net lithospheric thinning, for example, beneath Hawaii, where the maximum lithosphere thickness is equal to, or thinner than, normal oceanic lithosphere[131]. Similarly, in the central North Atlantic craton, the approximately 200-km-thick mantle root present throughout the Proterozoic eon[132,133] was thinned locally to 60 km by plume activity about 60 million years ago[134]. The Ontong Java plateau is an exception since mantle xenoliths reveal a lithosphere exceeding 120 km in thickness[135] but the uppermost 80 km formed from normal oceanic lithosphere[136]. Beneath Africa, seismology indicates that plumes are the sites of lithosphere erosion[137] and are implicated in plate destruction, not growth[138].

Geodynamic modelling of the dispersion of plume melting residues (Fig. 3; Supplementary Video 1), shows that excess mantle potential temperatures in the upwelling plume, in an ambient mantle that was around 200 K hotter than the present-day MORB source, are sufficient to counteract viscosity increases due to melt depletion. This allows rapid dispersal of residues by the plume mass flux, either back into the upper mantle or forming relatively thin, widespread layers of residual mantle, thus adding slightly to lithospheric depth but not attaining the 200 km thickness of most cratonic lithosphere. Compressional thickening is required to achieve cratonic root thicknesses. Buoyant plume residues seem to be effective at 're-cratonizing' lithosphere, after plume-related thinning, coalescing to re-form >150-km-thick lithosphere[89]. In contrast, the residues of high degrees of decompression melting at low average pressures in rift environments remain at their sites of generation. These residues form at lower mantle potential temperatures, cooling more rapidly to attain the high viscosities needed for stabilization of cratonic roots[3,139]. The lithospheric columns produced by such melting must then be thickened to the depths seen in cratonic roots.

The dominant lithosphere during Archean times was unlikely to have been as dynamic as in modern-day ocean basins, with perhaps only episodic mobility and nascent subduction-like features[139,140]. Hence, although extensive polybaric decompression melting at low average pressure is required by cratonic peridotite geochemistry, long-lived mid-ocean-ridge spreading centres may not have been as extensive in the Archean as in modern Earth. Other models of early Earth lithosphere dynamics invoke extensive melt extraction at sites of lithosphere rifting/divergence, leading to formation of segments of strong buoyant lithospheric 'blocks' via strain localization and cooling, sustaining further extension and melting[139]. The resulting mix of depleted lithospheric blocks can amalgamate and thicken via lateral compression/accretion and further cooling into approximately 200-km-thick, depleted, cool, cratonic lithospheric roots[141].

Data Journalism Examples

You can find many great examples of visualization used to accompany news articles online. To get you started, here are some examples that you may want to look at for inspiration (which is not to say these are all necessarily good or successful):

- Europe's record summer of heat and fires – visualised (The Guardian, link)
- Crime reporting behaviour of victims of unlawful police violence in Germany (Daria Babco, link)
- Cross-examination of a human right (Medicamentalia, link)
- How America's Thinking Changed Under Obama (FiveThirtyEight, link)
- How Americans Think About Climate Change, in Six Maps (The New York Times, link)
- Following the Science (The Pudding, link)
- Visualised: glaciers then and now (The Guradian, link)
- Lionel Messi Is Impossible (FiveThirtyEight, link)
- Who's In The Office? The American Workday In One Graph (NPR, link)
- A Really Small Slice of Americans Get to Decide Who Will Rule the Senate (Bloomberg, link)