

JUPITER MOON

LEARN'S NEWS



Divining the Virginia- Pennsylvania Border

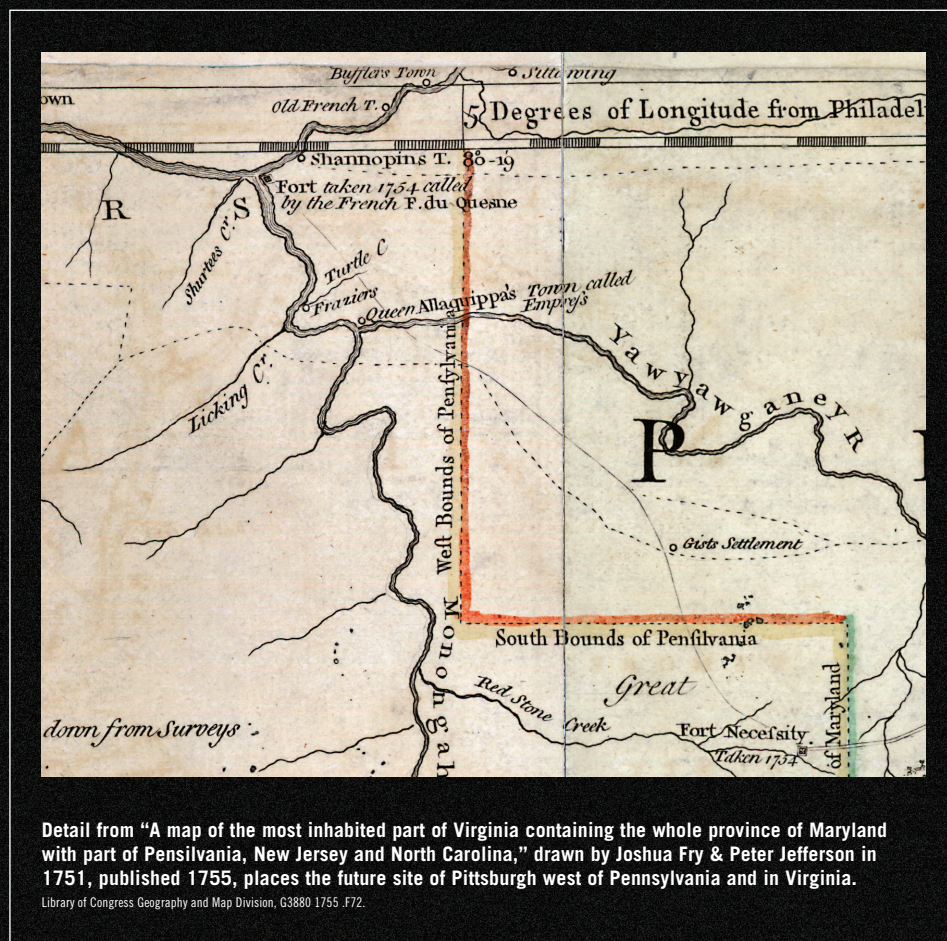
BY CHRISTOPHER BRIEM

When General John Forbes displaced French troops from Fort Duquesne in November 1758, he claimed the land at the forks of the Ohio River in the name of the British Empire. Departing barely a week after he arrived, Forbes never addressed a question that had already divided his colonial forces: was the new Pittsburgh part of Virginia or Pennsylvania?

Territorial disputes between Virginia and Pennsylvania were long-lasting, going unresolved even as the Revolutionary War came to a close. Ending the lingering ambiguity, and definitively marking Pennsylvania's southwest corner, would rely on the rediscovery of the astronomical calculations of Galileo. Even then, efforts were nearly thwarted by a volcanic eruption in Iceland that spread a month's-long dry, hazy fog across the northern hemisphere. A quarter century would pass before disputes over the boundaries of southwestern Pennsylvania would be finally resolved.

The region's ambiguous sovereignty was the result of disputed legal definitions for the borders of the two colonies and a lack of authoritative maps across the vast wilderness. One of the earliest maps of the region was drafted by surveyors Joshua Fry and Peter Jefferson in the early 1750s.¹ Perhaps reflecting the wishes of their sponsor, Virginia's acting governor Lewis Burwell, their 1753-published map labeled the area at the head of the Ohio River as part of Virginia.²

The head of the Ohio clearly rested north of Pennsylvania's agreed-upon southern border, a line of latitude extending westward from a point 15 miles south of Philadelphia. The astronomer Charles Mason and surveyor Jeremiah Dixon



had both determined the exact reference point, then marked much of that border in their epic journey between 1763 and 1767.

Mason and Dixon were hired by the Penn and Calvert families, heirs to Pennsylvania and Maryland, to resolve lingering border disputes

between the two British provinces. Traversing from east to west, Mason and Dixon were originally tasked only with proceeding as far as Maryland's farthest western extent, defined as the headwaters of the Potomac River, today just south of Ohiopyle, Pennsylvania. While en



New York and Pennsylvania, showing the Delaware River boundary extended directly to the west, sheet map by Emanuel Bowen and John Gibson, 1758.

Stanford Libraries, David Rumsey Map Center, David Rumsey Map Collection.

route their sponsors had extended their task to mark their line a full five degrees of longitude, or just over 266 miles west of Philadelphia. Roughly 30 miles short of that goal, they came upon the Catawba Warpath, and the Iroquois guides they relied on for safe passage refused to proceed further. Mason and Dixon were forced to conclude their expedition.³ The unfinished work left sovereignty over lands at the head of the Ohio River—and the British settlement at Pittsburgh—in dispute.

It was not just the breadth of Pennsylvania, but the shape of the commonwealth's western border that remained uncertain. William Penn's 1681 charter granted him lands extending five degrees of longitude westward from the Delaware River. Because the Delaware River ranges east and west by nearly 40 miles as it flows southward toward Chesapeake Bay, so would have Pennsylvania's notional western border. Where that meandering border rested in proximity to Pittsburgh was far from certain in the mid-18th century.

If a parallel Delaware River had ever been marked, downtown Pittsburgh would sit just three miles from the border. The bulk of the modern city of Pittsburgh would rest just within Pennsylvania, but about one-fourth of present-day Allegheny County would have been part of northern Virginia.

Alternative borders considered would have ceded even more of southwestern Pennsylvania to Virginia. In 1774 the Penns proposed that Pennsylvania's western border follow along the Monongahela River from where it intersects the Mason-Dixon Line to where the river flows into the Ohio River.⁴ If that border had been accepted, the triangle of land where Fort Pitt was located would have been classified as Pennsylvania, but all of modern Pittsburgh's southern and western neighborhoods would have been parts of Virginia.

Virginia, however, failed to support a 1774 proposal that could have placed most of modern Pittsburgh within Virginia. That year the



Transit and equal altitude instrument made and used by Andrew Ellicott.

Smithsonian's National Museum of American History, 152080.01.

Earl of Dartmouth, then serving as the British Secretary of the State for the Colonies, recommended a temporary border between the two commonwealths be fixed as a straight meridian extending northward from where an extension of the Mason-Dixon line crossed the Monongahela River.⁵ The Monongahela River intersects the Mason-Dixon line at 79.92 degrees west, a longitude that falls more than five miles east of Pittsburgh. Such a border would have placed all but the most easternmost neighborhoods of Pittsburgh today in Virginia.

Seeking resolution over the disputed border, in 1779 commissioners from Virginia and Pennsylvania met in Baltimore and agreed to a new and far more practical boundary. Upon ratification of the agreement in 1780 by their respective legislatures, both commonwealths agreed that Pennsylvania's western border was a straight meridian line that extended north from Pennsylvania's southwestern corner. That southwestern corner was agreed to be exactly five degrees of longitude west from the original reference point for the Mason-Dixon line, 15 miles south of Philadelphia.⁶

The agreement ended any realistic claims Virginia had on Pittsburgh and its immediate environs. The Virginia county court for Yohogania—which had only been created in 1776 and included Pittsburgh—last met in 1780. In 1781, Pennsylvania defined a new Washington County, which inherited legal records in the region, including those from Virginia courts.

The exact placement of the border had immediate consequences for early settlers in the region. By the 1780s, the region

was populated by landowners who had been granted titles via the conflicted and overlapping jurisdictions of both Pennsylvanian and Virginian courts. Though a preliminary survey of the extended Mason-Dixon line had been completed in the fall of 1783 by Virginian Joseph Neville and Alexander Mclean of Pennsylvania, land disputes persisted. To define and mark a definitive boundary, a joint boundary commission was sponsored by Pennsylvania and Virginia.

The total cost of the expedition would eventually exceed \$4,000, an extraordinary expense at the time for state governments whose treasures had been drained by the extended war for independence.⁷ The costs in no small part were ballooned by Pennsylvania's allocation of "sixty gallons of spirits, twenty gallons brandy, and forty gallons of Madeira wine" for use during their trek.⁸

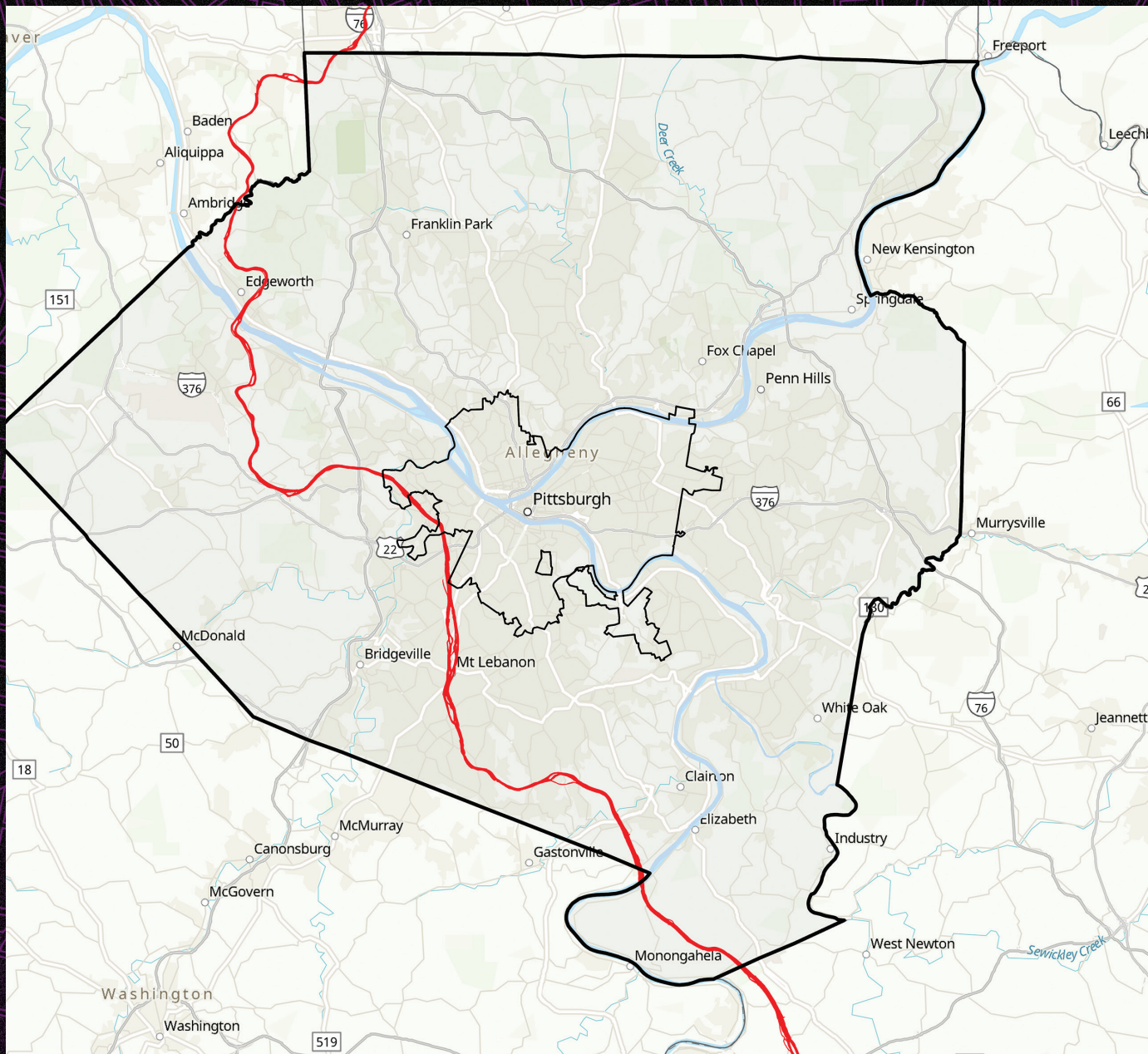
The commission included some of the top scientific minds of the new nation. Pennsylvania's delegation included astronomer David Rittenhouse as its senior commissioner, University of Pennsylvania provost John Ewing, and Thomas Hutchins, who would be appointed the first geographer general of the United States in 1785. Virginia's delegates included the Right Reverend James Madison, principal of William and Mary College, who would be named the Episcopal Bishop of Virginia in 1785; and perhaps most notably, the surveyor Andrew Ellicott, who had been born in Bucks County, Pennsylvania, but later moved with his family to Maryland.⁹

The commission was split between a group led by Rittenhouse that set up a base for celestial observations in eastern Pennsylvania—in close proximity to the agreed-upon eastern reference point for the Mason-Dixon line—and an expedition including Madison, Ewing, and Ellicott that would trek westward to find and mark Pennsylvania's southwestern corner. The coordinated work of both groups was essential to achieving the most accurate placement of Pennsylvania's southwest corner.



*Surveyor
Andrew Ellicott
(1754-1820)
by Jacob
Eichholtz, oil
on wood panel,
1809.*

New-York Historical Society, gift of Mrs. Thomas Clapham, 1916.3.



Modern boundaries of the City of Pittsburgh and Allegheny County, with a red overlay of the Delaware River displaced five degrees westward.

Map by Christopher Briem.

Navigation was a rapidly evolving science in the 18th century. In an era long before electronic and satellite technology, precision beyond the line of sight from known landmarks relied on celestial navigation, which required highly accurate measurement of observable celestial bodies such as the sun, moon, planets, and major stars.

Marking a precise location is actually two distinct problems requiring

the determination of both latitude and longitude, each of which presented unique challenges at the time. The practical calculation of latitude, or the angular distance north or south of the equator, had been solved for centuries. Sailors with a clear view of the horizon could accurately determine latitude by measuring the azimuth of the sun at its noon peak each day. Even without being able to determine longitude, the



Left: Trade card from 1788 of landscape gardener Humphry Repton, designed by Repton and engraved by Thomas Medland.

The Gardens Trust.

Below: Portable compasses such as this allowed 18th-century surveyors to accurately measure distances and mark boundaries. This brass instrument was made in either Maryland or Pennsylvania by Benjamin Chandlee Jr. in the second half of the 18th century.

Fort Pitt Museum, PHMC Collection.

precisely determining a reference time anywhere on the planet by observing the eclipses of Jupiter's largest moons. To observers anywhere on earth, the largest Jovian moons appeared to eclipse, or pass behind Jupiter, at the same time. The precise times that the moons passed behind the planet, called immersion, or the exact time they reemerged, can not only be predicted but occurred on a periodic schedule. Pennsylvania's southwest corner would be located by the simultaneous observations of the eclipses of Jupiter's moons from both ends of Pennsylvania.

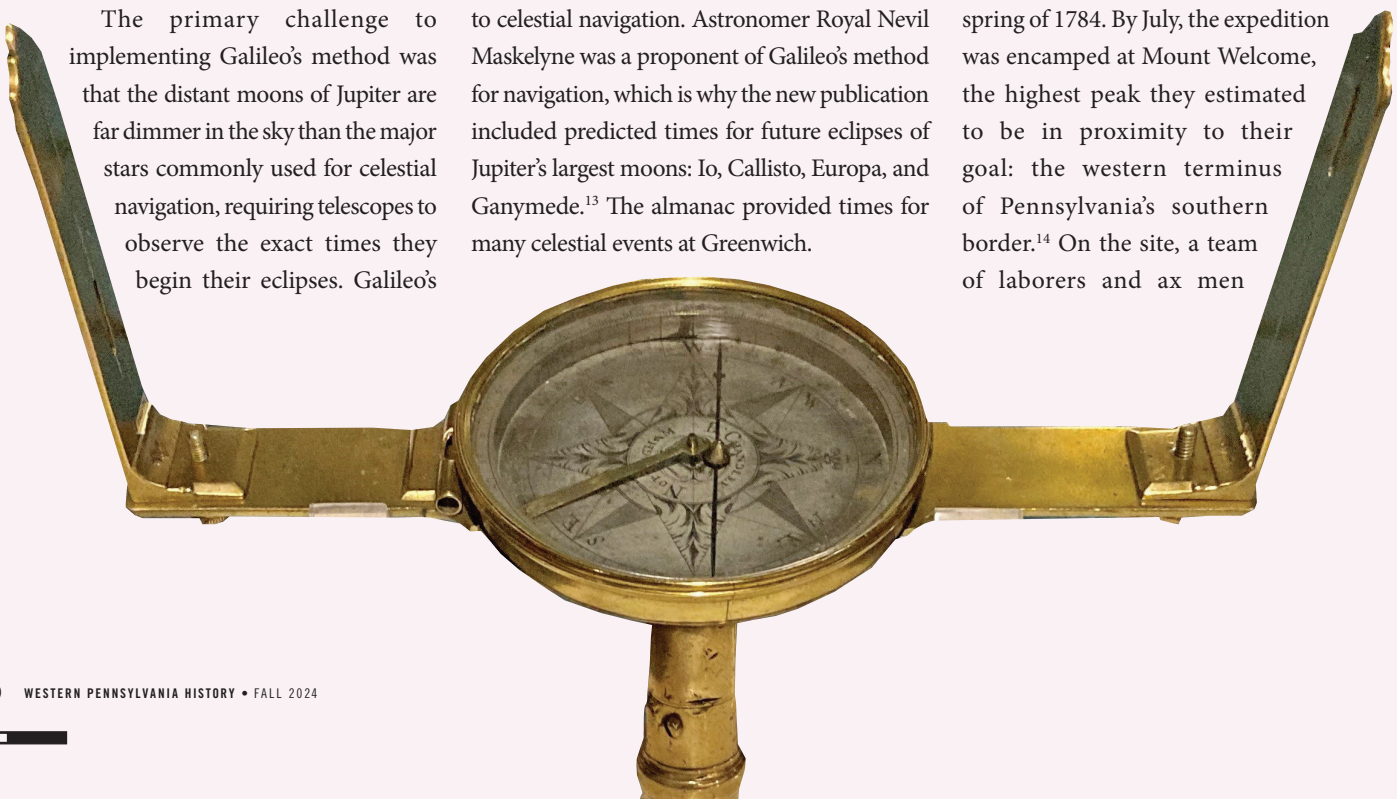
The primary challenge to implementing Galileo's method was that the distant moons of Jupiter are far dimmer in the sky than the major stars commonly used for celestial navigation, requiring telescopes to observe the exact times they begin their eclipses. Galileo's

method had proved impractical for marine navigation due to the difficulty of using telescopes on ships at sea, while navigators were inevitably buffeted by wind and waves. As a result, Galileo's method was rarely used for navigation, and there were few sources of the essential celestial data needed to implement it.¹²

The lack of reference data was solved when the first edition of the *Nautical Almanac* was published in 1767 by the Royal Observatory in Greenwich, England. The encyclopedic work included a wealth of astronomic data essential to celestial navigation. Astronomer Royal Nevil Maskelyne was a proponent of Galileo's method for navigation, which is why the new publication included predicted times for future eclipses of Jupiter's largest moons: Io, Callisto, Europa, and Ganymede.¹³ The almanac provided times for many celestial events at Greenwich.

Andrew Ellicott's expertise included surveying and watchmaking, but he was also the foremost American expert on the nautical almanac. In 1781 he authored a North American version of the nautical almanac published by Baltimore postmaster and newspaper publisher Mary Goddard. In it he adjusted the celestial data in the Royal Observatory's publication to reference Baltimore in place of Greenwich.

Ellicott, along with his fellow commissioners Madison, Hutchins, and Ewing, departed Philadelphia in the spring of 1784. By July, the expedition was encamped at Mount Welcome, the highest peak they estimated to be in proximity to their goal: the western terminus of Pennsylvania's southern border.¹⁴ On the site, a team of laborers and ax men



began construction of an ad-hoc astronomical observatory unlike any other structure on the frontier, or possibly anywhere in North America at the time. The critical observations were made from a temporary cabin that seemed to defy the purpose most structures had to provide protection from the elements. Unlike cabins intended primarily to protect their inhabitants, the cabin built atop Mount Welcome included a retractable roof that could be opened to the sky.¹⁵

Once their temporary camp was complete, the commissioners used their specialized observatory to begin a daily routine, making observations of the sun in the morning and Jupiter's moons in the evening. Marking when the sun reached its noon peak each day was critical to synchronizing their clocks and setting the local time. By comparing the local time of a predicted eclipse of one of Jupiter's moons to the time predicted in the nautical almanac, the longitude between the observer and the reference point for the almanac could be calculated. Comparing observations made at both ends of Pennsylvania ensured that the precise location exactly five degrees west of the reference point in eastern Pennsylvania was found.

Compiling sufficient measurements took several weeks. Light pollution, especially on the American frontier, was not the threat it is to stargazing today, but there were unanticipated atmospheric challenges. Not only did the weather not cooperate to provide the requisite clear skies, but there was also a persistent and abnormal haze that made it far more difficult than normal to collect the precise observations that were critical to the success of the expedition.

Unknown at Mount Welcome, a 1783 volcanic eruption in Iceland had persisted for eight months, ejecting an estimated 14 cubic kilometers of lava, 80 million tons of sulfuric acid aerosol, and an incalculable volume of volcanic soot high into the atmosphere. The resulting haze was reported across much of the planet, cooling the entire planet by over a degree Celsius, while



the eastern United States experienced a winter nearly 4.8 degrees Celsius below average.

In Iceland, the darkened sky killed most of the island's livestock, caused widespread crop failure due to acid rain, and resulted in the deaths of one-quarter of the human residents. While in France, American diplomat Benjamin Franklin noted the abnormal "universal fog" and was among the very first to suggest it might

be caused by volcanic eruptions in Iceland.¹⁶

He remained unaware of the impact on the occluded atmosphere on the detailed astronomic calculations along the border of his home state across the Atlantic.¹⁷

It was not until September 1784 that the team on the western end of the state believed they had made sufficient observations and sent their data back to Philadelphia. David



Rittenhouse, who had been making comparable observations south of Philadelphia, came west with the data that had been collected by his team. When the two sets of data were reconciled, calculations showed that the encampment on Mount Welcome was just a few hundred yards short of Pennsylvania's southwest corner.

Having fixed their position on Mount Welcome to a high degree of accuracy, more conventional survey techniques were used to extend the final short segment of Pennsylvania's southern border. At Pennsylvania's southwest corner, the team laid down a definitive marker.

When measured a century later, the original location marked in the fall of 1784 was found to be just 23 feet past the intended longitude, exactly five degrees west of Philadelphia.¹⁸

The joint boundary commission concluded its work and issued a final report. Ellicott returned to Western Pennsylvania in 1786 to map the commonwealth's western border that extended due north from the corner marker, one of many important borders that would be known as the Ellicott Line. Andrew Ellicott would also go on to complete even greater cartographic projects, including completing the work Pierre L'Enfant began in planning and laying out the future District of Columbia, mapping the young nation's southern border with Spanish territories, and laying out the city of Erie, Pennsylvania.

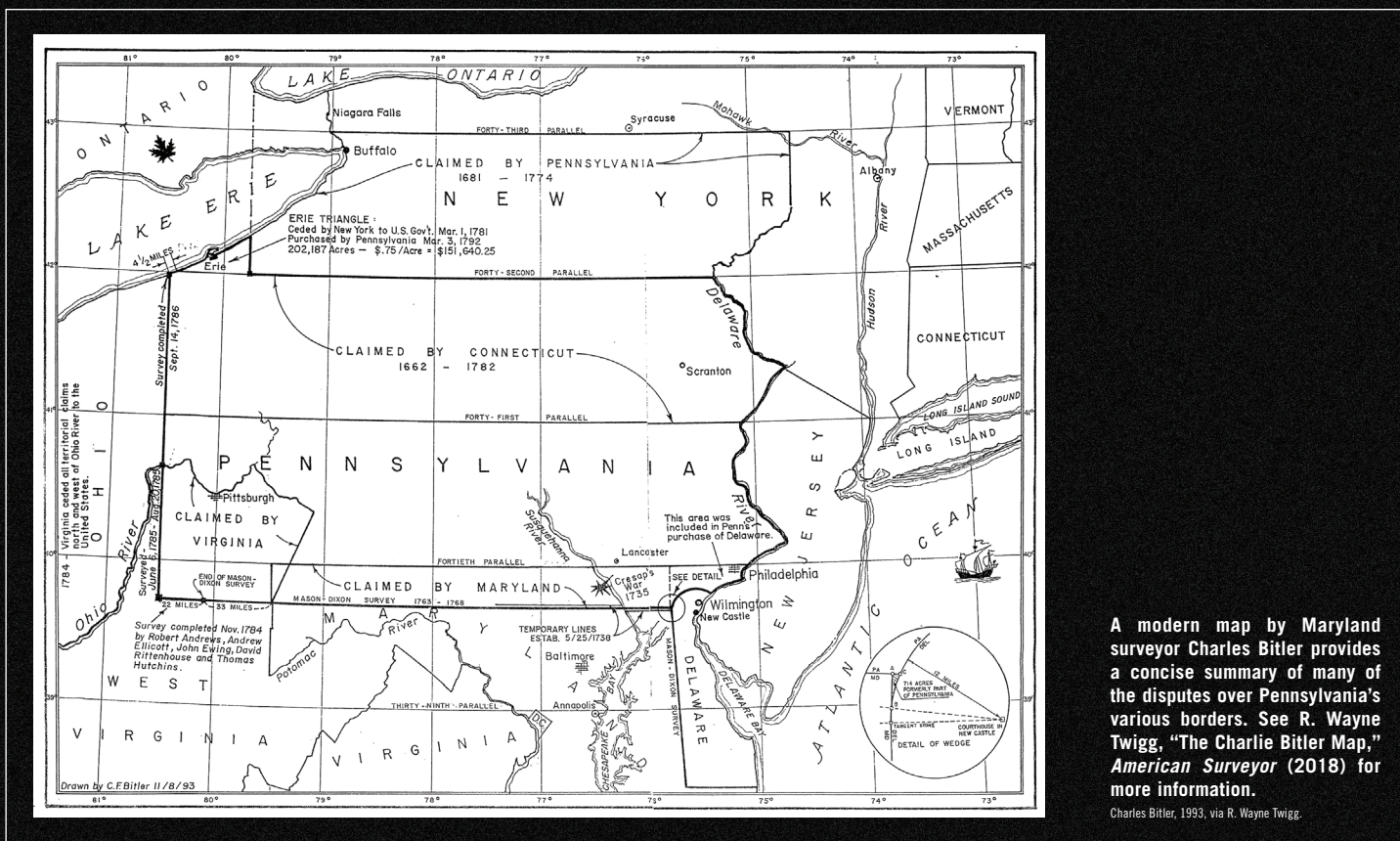
The maps submitted by the Joint Commission were accepted as authoritative by both Virginia and Pennsylvania. The resolution of lingering property disputes removed one of the factors limiting migration and investment across the region. Just a few years after the completion of the work of the joint commission, Pennsylvania was empowered to define a new western county named Allegheny in 1788, with the growing settlement at Pittsburgh named as its county seat.



"A map of the country between Albemarle Sound, and Lake Erie, comprehending the whole of Virginia, Maryland, Delaware and Pennsylvania, with parts of several other of the United States of America," London, John Stockdale, 1787.

Library of Congress Geography and Map Division, G3790 1787 J4.

Christopher Briem is a regional economist in the Urban and Regional Analysis program at the University of Pittsburgh's Center for Social and Urban Research. He has also served in the U.S. Naval Reserve for the last 38 years. Before being commissioned as an officer, he served 18 years as a Navy quartermaster, the Navy enlisted rating charged with shipboard navigation, including celestial navigation.



A modern map by Maryland surveyor Charles Bitler provides a concise summary of many of the disputes over Pennsylvania's various borders. See R. Wayne Twigg, "The Charlie Bitler Map," *American Surveyor* (2018) for more information.

Charles Bitler, 1993, via R. Wayne Twigg.

¹ Peter Jefferson was the father of the future president, and Joshua Fry would later become the first colonel of the Virginia Regiment, making him briefly George Washington's immediate superior officer before his death in May 1754. See "A map of the most inhabited part of Virginia containing the whole province of Maryland with part of Pensilvania, New Jersey and North Carolina," online at: <https://www.loc.gov/item/74693166/>.

² Fry and Jefferson identified a section of the "West Bounds of Pensylvania" along a meridian line identified as five degrees west of Philadelphia, which they incorrectly placed nearly 15 miles east of Pittsburgh. Though Fry and Jefferson's map had been commissioned by the acting governor of Virginia, Lewis Burwell, the error could easily have resulted from even the published values for the longitude of Philadelphia at the time being off by up to five miles. See Thomas D. Cope, "Degrees along the West Line, the Parallel between Maryland and Pennsylvania," *Proceedings of the American Philosophical Society* 93 no. 2 (1949), 128.

³ Cameron B. Strang, "The Mason-Dixon and Proclamation Lines: Land Surveying and Native Americans in Pennsylvania's Borderlands," *The Pennsylvania Magazine of History and Biography*, 136, no. 1 (January 2012), 21.

⁴ John E. Potter, "The Pennsylvania and Virginia Boundary Controversy," *The Pennsylvania Magazine of History and Biography*, 38, no. 4 (1914), 412.

⁵ On Lord Dartmouth's letter, see Percy B. Caley, "Lord Dunmore and the Pennsylvania-Virginia Boundary Dispute," *Western Pennsylvania Historical Magazine* 22 (June 1939), 95-96.

⁶ Potter, 417.

⁷ Andro Linklater, *Fabric of America* (New York: Walker Books, 2007): 5.

⁸ Boyd Crumrine, "The Boundary Controversy Between Pennsylvania and Virginia: 1748-1785," *Annals of the Carnegie Museum*, Volume 1, No. 4 (September 1902), 524, at <http://www.digitalscholarship.org/digital/collection/books/id/84965/>.

⁹ Andrew Ellicott's father, Joseph Ellicott, and his two brothers, Andrew and John, founded Ellicott Mills, later Ellicott City, Maryland, in the 1770s.

¹⁰ Cope, "Degrees," 128.

¹¹ Cope, "Degrees," 132.

¹² Kaare Aksnes, "Navigation, world mapping and astrometry with Galileo's moons," *Proceedings of the International Astronomical Union*, 6 (2010): 43. doi:10.1017/S1743921310007258.

¹³ Paul Edwards, "Innovation and intrigue: Nevil Maskelyne's rise," *Astronomy & Geophysics* 56 no. 6, (December 2015), 6.35, at <https://doi.org/10.1093/astrogeo/atv200/>.

¹⁴ The label "Mount Welcome" seems to have at most ethereal references anywhere now or in the past. I tried to visit the corner of the state, but the closest roads are difficult to pass and very clearly marked with not recent "no trespassing" signs and cameras. Some local farms are in close proximity, but with no obvious sign of any local heights. I conjecture that modest agricultural terraforming over the centuries has made anything that was once "Mount Welcome" unrecognizable today.

¹⁵ Linklater, 4; see also Catharine Van Cortlandt Mathews, *Andrew Ellicott, his life and letters* (New York: Grafton Press, 1908), 3.

¹⁶ Franklin's alternative conjecture was that the atmospheric conditions were caused by meteors, or the "great burning balls or globes which we happen to meet with in our rapid course round the sun, and which are sometimes seen to kindle and be destroyed in passing our atmosphere."

¹⁷ Alexandra Witze and Jeff Kanipe, *Island on Fire: The extraordinary story of Laki, the forgotten volcano that turned eighteenth-century Europe dark* (London: Profile Books, 2014), 125; see also Linklater, 17.

¹⁸ Cope, "Degrees," 132.

