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Alexander von Humboldt and the Mapping of Mexico

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Summary: Alexander von Humboldt's landmark map of New Spain is widely regarded as marking a major turning point in the cartography of present-day Mexico and the Southwestern United States. The map is unusually well documented for its time, and it marks an important step towards the application of modern "scientific" methods to the mapping of much of North America. Nonetheless, a careful analysis of the sources Humboldt used reveals a great deal of continuity between Humboldt's map and those of his predecessors, particularly José Antonio de Alzate y Ramírez and Aaron Arrowsmith. Humboldt's methodological sophistication and conscientious work were unable to overcome many of the numerous obstacles to producing a planimetrically accurate map of New Spain.

Introduction

Alexander von Humboldt's overview map of New Spain (Fig. 1), first published in 1808, is widely recognized as a landmark in the history of cartography.¹ It was seen by contemporaries as superseding all previous maps of Mexico, and it heavily influenced later maps of that country through the first half of the nineteenth century.

Aside from its intrinsic importance, this map poses significant questions about its construction. Like most small or medium-scale maps made prior to the middle of the nineteenth century, it was cobbled together from various sources, including a large number of Spanish or Mexican maps, along with Humboldt's own surveys and observations in central Mexico. This makes one wonder: How original was Humboldt's work? What sources did he actually use, and how did he use them? How accurate was his work in comparison with that of his predecessors and successors?

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¹ Alexander von Humboldt, *Carte générale du royaume de la Nouvelle Espagne depuis le parallèle de 16° jusqu'au parallèle de 38° (latitude nord). dressée sur des observations astronomiques et sur l'ensemble des matériaux qui existoient à Mexico, au commencement de l'année 1804*. The earliest printed edition of this map appeared in 1808, and was published as two sheets of his *Atlas géographique et physique du royaume de la Nouvelle-Espagne, fondé sur des observations astronomiques, des mesures trigonométriques et des nivellements barométriques* (Paris: F. Schoell and Tubingen: J.G. Cotta). The 1808 edition is available online from the University Complutense (Madrid) at http://dioscorides.ucm.es/proyecto_digitalizacion/index.php?doc=b23177585&y=2010&p=1. An 1811 printing of the atlas by Schoell, which is sometimes cited as the first edition of this work, is available in its entirety from the David Rumsey Collection. To confuse matters further, the map is dated 1809 in both the 1808 and the 1811 editions of the atlas. Used for this project is a composite of the two sheets from the 1811 printing made available on the Web by David Rumsey at <http://www.davidrumsey.com/luna/servlet/s/p616lm>.

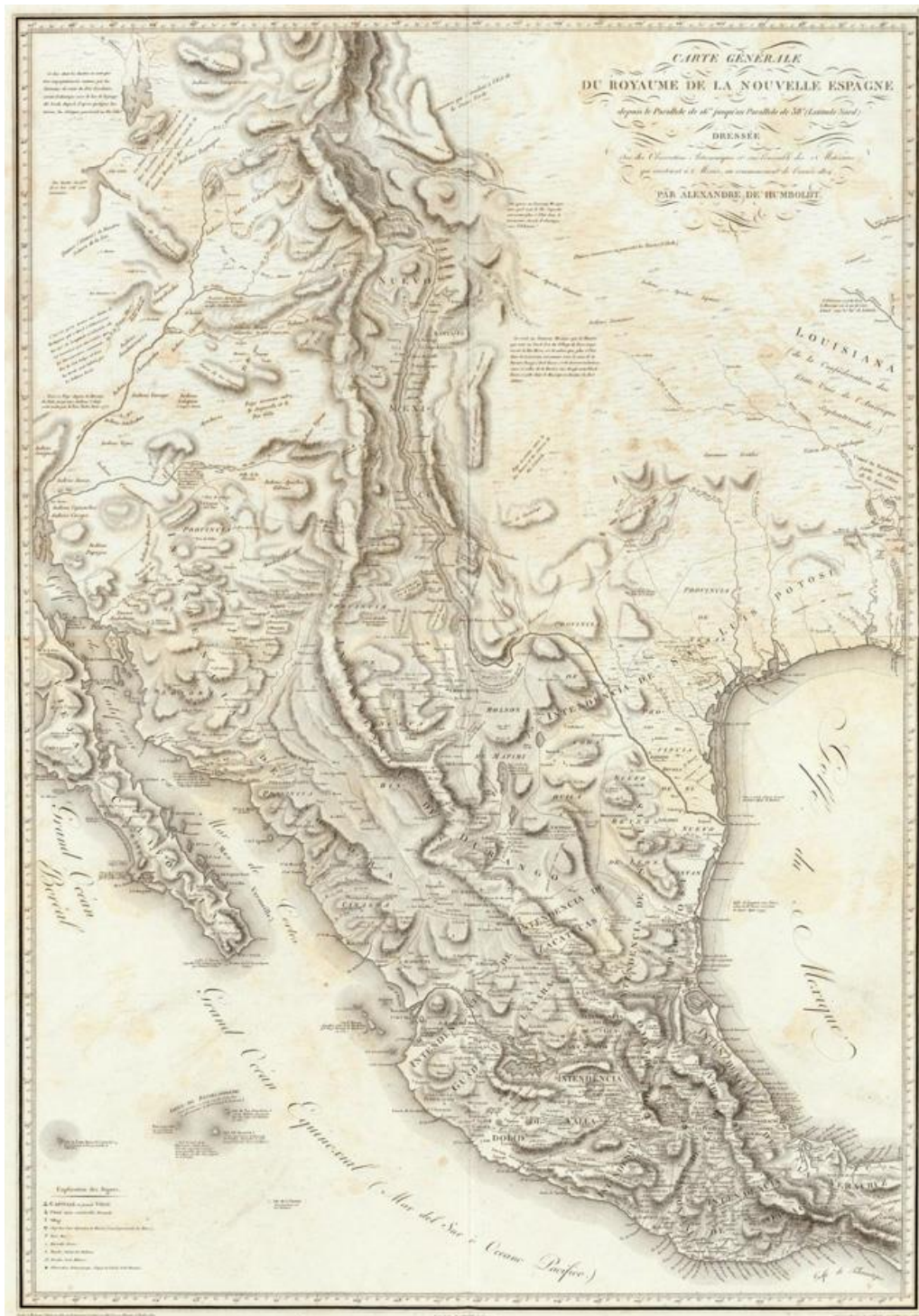


Figure 1: Alexander von Humboldt, *Carte Generale du Royaume de la Nouvelle Espagne* (1811). Composite of two sheets from atlas first published in 1808. David Rumsey Collection.

Humboldt's map of New Spain is especially interesting for someone pursuing this line of research because he was unusually explicit about how he carried out his task. The "Geographical Introduction" to his *Political Essay on the Kingdom of New Spain* contains extensive information about how he compiled this map, including lists of maps and other sources he used, and a table of longitude and

latitude measurements he considered reliable.² This type of detailed information cannot be found for most maps published in the eighteenth and early nineteenth centuries.

Of additional interest, Humboldt made his map in the early stages of an important transition to more modern forms of cartography. This is reflected to some extent in his preoccupation with documenting his sources, as well as in his use of such instruments as barometers to measure elevation and chronometers to measure longitudes. Humboldt's map sheds some light on the nature of the significant changes that took place in cartography between approximately 1750 and 1850.³

In spite of the transitional character of Humboldt's mapping, this particular map is basically a late example of the kind of work practiced by Enlightenment cartographers like Delisle, rather than an innovative work pointing toward types of mapping more characteristic of the middle of the nineteenth century. An analysis focusing just on Humboldt's map of New Spain can give a somewhat misleading and overly negative picture of him as a cartographic innovator. Humboldt did play a major role in the development of thematic mapping and other new forms of cartographic expression, but few of these contributions are reflected on his map of New Spain, although more can be found on other maps of Mexico that appeared in the atlas in which this overview map was published. Any overall evaluation of Humboldt's place in the history of cartography, which is beyond the scope of this article, needs to consider all of his maps, not just this map of New Spain.⁴

Humboldt's Predecessors

Humboldt's dependence on earlier maps has been widely recognized and discussed, mostly by Mexican scholars.⁵ Although his map of New Spain was first published in 1808, the manuscript on

² Alexander von Humboldt. *Essai politique sur le royaume de la Nouvelle-Espagne* (Paris: F. Schoell, 1811). Cited here is the English translation by John Black, *Political Essay on the Kingdom of New Spain* (London: Longman, 1811).

³ For a brief overview of Humboldt's work, see Imre Josef Demhardt, "Alexander von Humboldt: Scientific Discoverer and Cartographer of the Americas", *The Portolan* 82 (Winter, 2011), 18-26. Works on the place of Humboldt in the history of cartography include: Anne Marie Claire Godlewska, *Geography Unbound: French Geographic Science from Cassini to Humboldt* (Chicago: Chicago University Press, 1999); Michael Dettelbach, "Humboldtian Science," in N. Jardine, et. al., eds. *Cultures of Natural History* (Cambridge: Cambridge University Press, 1996), 287-304.

⁴ Humboldt's original *Atlas géographique* is very rare, but the entire atlas is readily available on the David Rumsey site. An important annotated edition of Humboldt's atlas, which includes several important maps of Mexico published after 1811, is *Atlas géographique et physique du royaume de la Nouvelle-Espagne. Vom Verfasser auch kurz benannt: Mexico-Atlas. Neudruck des 1811 [i.e. 1812] in Paris erschienenen Werkes. Verm. um die "Introduction géographique" des Essai politique du royaume de la Nouvelle-Espagne, die jede Tafel des Mexiko-Atlases"erläutert, sowie um 7 Karten des Atlas géographique et physique des régions équinoxiales du nouveau continent (Paris, 1814-1834) und eine Bildtafel aus den "Vues des Cordillères"(Paris, 1813) die Mexico betreffen*, eds. Hanno Beck and Wilhelm Bonacker (Stuttgart, Brockhaus, 1969). Some perceptive observations on the making of the individual maps in Humboldt's atlas can also be found in Rayfred Lionel Stevens-Middleton, *La obra de Alexander von Humboldt en México: fundamento de la geografía moderna* (México, D.F.: Sociedad Mexicana de Geografía y Estadística, 1956), 41-67.

⁵ Those who do not read Spanish can find some information on the relationship between Humboldt and his predecessors in Magali M. Carrera, *Traveling from New Spain to Mexico: Mapping Practices of Nineteenth-Century Mexico* (Durham and London: Duke University Press, 2011), 66-83. The most important discussions of this subject in Spanish are: Manuel Orozco y Berra: *Apuntes para la historia de la Geografía en México* (Mexico City: Imprenta de Francisco Díaz de León, 1881), 334- 43; Michel Antochiw, "La Visión Total de la Nueva España. Los Mapas Generales de Siglo XVIII," in Héctor Mendoza Vargas, ed., *México a través los mapas* (Mexico City: Instituto de

which it was based was largely compiled during his visit to Mexico in 1803 and 1804.⁶ Only a few changes appear to have been made later based on information that Humboldt received after 1804.

Humboldt maintained that all previously published maps of New Spain were deficient and unreliable.⁷ There is considerable substance to this criticism, for much of Mexico was poorly explored, and mapmakers based in Europe, or even in Mexico City, were not in a good position to collect and evaluate what evidence existed. They often uncritically copied from earlier maps, thereby perpetuating for centuries egregious errors, such as the notion that California is an island. According to Humboldt, there had been little improvement over the years, and he had especially unkind words for the two recent maps that came closest to rivaling his own-one by José Antonio Alzate y Ramírez (1737-99), and the other by Aaron Arrowsmith (1750-1823). It is worth examining these two maps to see in what ways they resembled and differed from Humboldt's production.

At the end of the eighteenth century, it was widely thought that the best map of New Spain was Alzate's *Nuevo mapa geographico* (1767), which was published by the Academy of Sciences of Paris in 1768 (see Fig. 2)⁸. It apparently used as its underlying framework a lost manuscript map created by the Mexican savant Sigüenza y Góngora at the end of the seventeenth century. Humboldt claimed that Alzate's map was no more than a copy of Sigüenza's, but Alzate certainly updated Sigüenza's work with more recent information. Even so, Alzate's map was compiled before the publication of an important group of maps covering much of Mexico, which appeared between 1769 and 1800, and were known to Humboldt.

Humboldt regarded Alzate's work as careless, and stated explicitly that he made "no use" of his map in constructing his own.⁹ But many of Alzate's methods of evaluating and collating sources were similar to those used by Humboldt,¹⁰ and a comparison of the two maps shows some striking similarities, which suggest that Humboldt may have either copied portions of Alzate's work, or that

Geografía, Universidad Nacional Autónoma de México, 2000), 71-88; Elías Trabulse, "La cartografía en la historia de la ciencia en México," in Elías Trabulse, ed. *Cartografía mexicana: tesoros de la nación, siglos XVI a XIX*. (México City: Archivo General de la Nación, 1983), 8-32; José Omar Moncada Maya, "Humboldt y el desarrollo de la cartografía mexicana", in Frank Holl, ed., *Alejandro de Humboldt en México* (Mexico City: Instituto Nacional de Antropología e Historia, 1997).

⁶ Although there are no extant copies of the early manuscript versions Humboldt's map, a map of New Spain made by Juan Segura in 1803 is clearly a copy of an early version of it. See Dennis Reinhartz, "Alexander von Humboldt: His Earliest Surviving Map of New Spain," *IMCOS Journal* 21 (Summer 2010), 13-18. In 1804 Humboldt presented a copy of his map to Thomas Jefferson, but that manuscript appears to be lost. The Library of Congress has a copy of Humboldt's map dated 1804 on its Web site at <http://hdl.loc.gov/loc.gmd/g4410.ct000554>, but this appears to be a manuscript copy of the printed 1811 version of Humboldt's map made during the Mexican-American war by American military cartographer Joseph Goldsborough Bruff.

⁷ "Geographical Introduction", *Political Essay on the Kingdom of New Spain*, lxxv-lxxxiii. (Hereafter cited as "Geographical Introduction").

⁸ Alzate y Ramírez, José Antonio de. *Nuevo mapa geographico de la America septentrional, perteneciente al Virreynato de Mexico: Dedicado à los sabios miembros de la Academia Real de la Ciencias de Paris* (Paris : Chez Dezauche, 1768). A later issue is entitled. *Nuevo mapa geographico de la America septentrional, perteneciente al Virreynato de Mexico. Dedicado à los sabios miembros de la Academia Real de las Ciencias de Paris por su muy rendido servidor, y capellan, Don Joseph Antonio de Alzate y Ramirez, Año de 1769*. (Paris; Buache, 1772); Available on the Web from Harvard University Library at <http://ids.lib.harvard.edu/ids/view/26003923?buttons=y>; a still later issue, dated 1779 or later, is available on the Web from the John Carter Brown Library at <http://jcb.lunaimaging.com/luna/servlet/s/0kifui>.

⁹ For Humboldt's comments on Alzate and Sigüenza, see "Geographical Introduction", lxxv.

¹⁰ For a careful analysis of Alzate's work, see Mitchell A. Coddington, "Perfecting the Geography of New Spain: Alzate and the Cartographic Legacy of Sigüenza y Góngora", *Colonial Latin American Review* 3:1-2 (1994): 185-219.

both cartographers relied on the same sources. The similarities and differences between the two maps will be discussed in the following section.



Figure 2: José Antonio de Alzate y Ramírez, *Nuevo mapa geographico de la America septentrional, perteneciente al Virreynato de Mexico*, 1769. Harvard University Library.

Humboldt was also very critical of all other recent published maps of Mexico, including those of such highly regarded cartographers as Delisle, Jeffreys, Bonne, and Arrowsmith. Regarding Arrowsmith's 1803 map of Mexico, he remarked: "It appears astonishing that the most recent map which we possess of that part of New Spain which we are analyzing, and which bears the name of a justly esteemed author, should be the falsest of all. I speak of the large English map, which has for title, *Chart of the West Indies and Spanish Dominions in North America*, by Arrowsmith, published in June 1803" (Fig. 3). He specifically criticized Arrowsmith for his errors in place names and locations: "From Mexico to Vera Cruz the names appear to be scattered at random", and he added for good measure that Arrowsmith's mislocation of the Pic d'Orizaba "might prove dangerous to navigators".¹¹

¹¹ "Geographical Introduction", xlv-xlvii. Compare with Aaron Arrowsmith, *Chart of the West Indies and Spanish Dominions In North America* (London: Arrowsmith, 1803), <http://www.davidrumsey.com/luna/servlet/s/7ib6ip>.



Figure 3: Aaron Arrowsmith. *Chart Of The West Indies And Spanish Dominions In North America*, 1803 (portion showing New Spain). David Rumsey Collection.

Here too Humboldt's harsh words need to be qualified: As will be seen below, Arrowsmith's map does indeed have serious weakness in its handling of places and locations. Most displacements are greater than on either Alzate's or Humboldt's maps, and they appear to be more random, except in central Mexico, where locations are shifted consistently to the west. A close examination also reveals numerous typographic errors and a variety of other omissions and mistakes in place names, which indicate careless and indiscriminate copying. On the other hand, Arrowsmith took advantage of recent hydrographic mapping by the Spanish Navy to produce an improved outline of Mexico's coasts. Arrowsmith's depiction of the Gulf Coast is taken wholesale from a Spanish nautical chart, and he used other recent Spanish nautical charts to depict the Pacific Coast of Mexico. Consequently, he was able to capture Mexico's outline much better than Alzate, and Arrowsmith also made a respectable attempt to depict Mexico's topography and provincial boundaries. A close comparison of the place names on the Arrowsmith and Alzate maps suggests that Arrowsmith derived most of his names (albeit with numerous copying errors) from Alzate. Thus, his map is a synthesis of the best maps available at the time. Although full of imperfections, it is (as even Humboldt admitted) beautifully designed and engraved.

Although Humboldt was overly critical of his predecessors, he nonetheless did succeed in surpassing them in many respects. He had access to numerous sources that were unavailable to Alzate or Arrowsmith, including important manuscript maps of New Spain made by military cartographers

between 1768 and 1800. He was also able to incorporate his own knowledge and observations in his work. To understand how Humboldt actually went about synthesizing these materials, it is necessary to examine more closely the works of Humboldt and his predecessors.

Overview Analysis of Humboldt's Map of New Spain

For my initial analysis of Humboldt's map I used the computer program MapAnalyst to assess its overall accuracy. Among other things, MapAnalyst enables one to compare maps with each other by producing displacement vectors and distortion grids. For this project, I compared a composite of the two sheets of Humboldt's map with MapAnalyst's default Open Street Map, which worked well for this purpose, since it uses the Mercator Projection, which was also chosen by Humboldt.¹² Some basic features of the map are revealed by the patterns of displacement vectors shown below (Figure 5), and its differences with the Alzate and Arrowsmith maps can be assessed by comparing these patterns with those shown as Figures 6 and 7.

Somewhat ironically, Humboldt himself was a pioneer of this type of analysis. His atlas of New Spain contains a map (*Carte de fausses positions de Mexico, Acapulco, Veracruz et du Pic d'Orizaba*), which shows by means of multiple symbols the inaccuracies of previous maps of central Mexico (see Fig. 4).¹³



Figure 4: Alexander von Humboldt, *Carte des fausses positions*. David Rumsey Collection.

The displacement vectors shown by MapAnalyst do more than demonstrate inaccuracies in Humboldt's map. They also uncover patterns which tell us much about how it was compiled, and provide clues about the sources he utilized for specific areas.

¹² For information about MapAnalyst, see <http://mapanalyst.org/>. For more on working with MapAnalyst and eighteenth-century maps see Thomas A. Weiss, "MapAnalyst and Geographic Information Systems: Keys to Unlocking New Paths of Research in the History of Cartography", *The Portolan* 86 (Spring, 2013), 10-35.

¹³ This is his *Carte de fausses positions de Mexico, Acapulco, Veracruz et du Pic d'Orizaba* (Paris: J.H. Stone, 1811), <http://www.davidrumsey.com/luna/servlet/s/0285fz>.

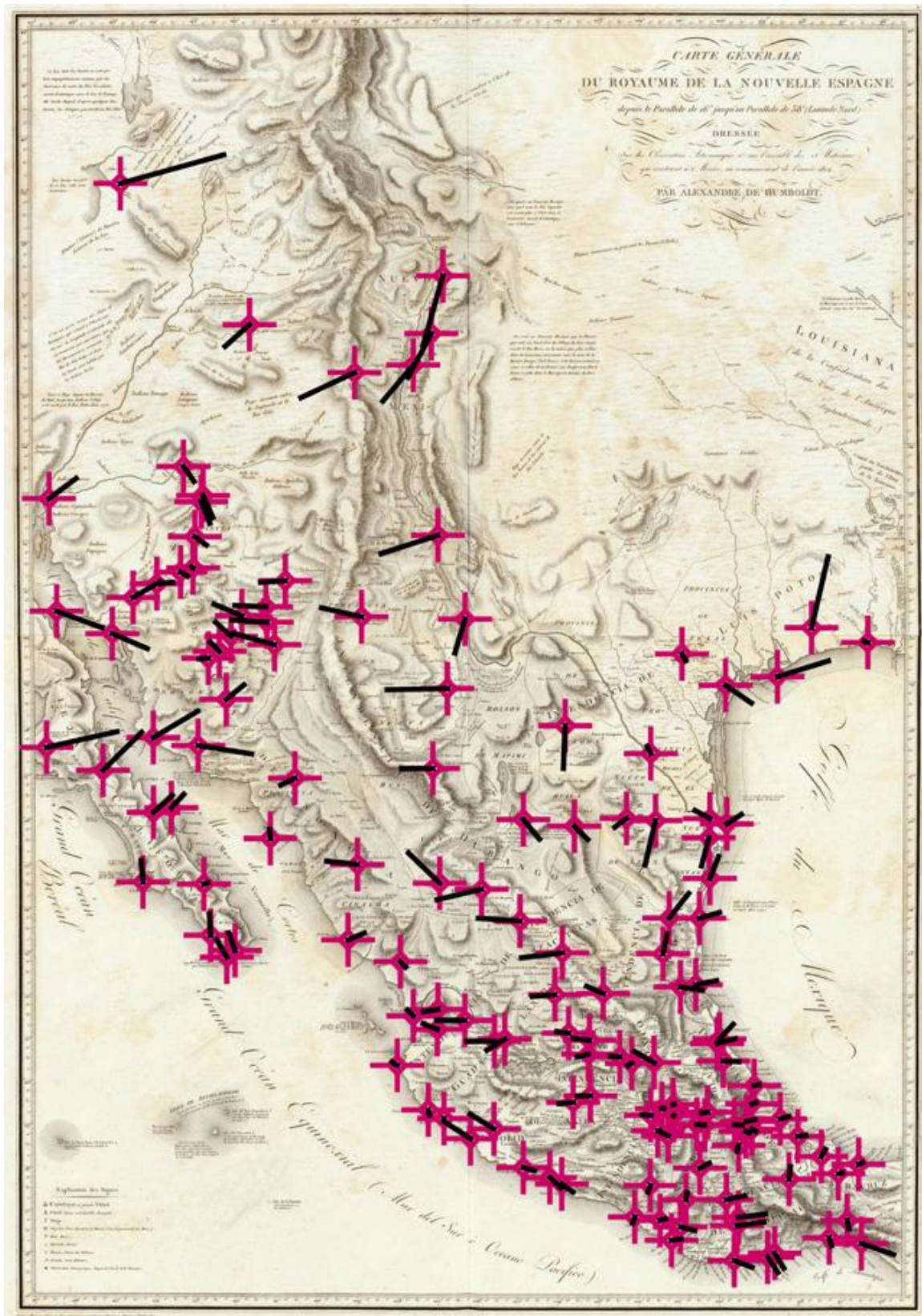


Figure 5: Displacement vectors on Humboldt's map of New Spain.



Figure 6: Displacement vectors on Alzate's map.

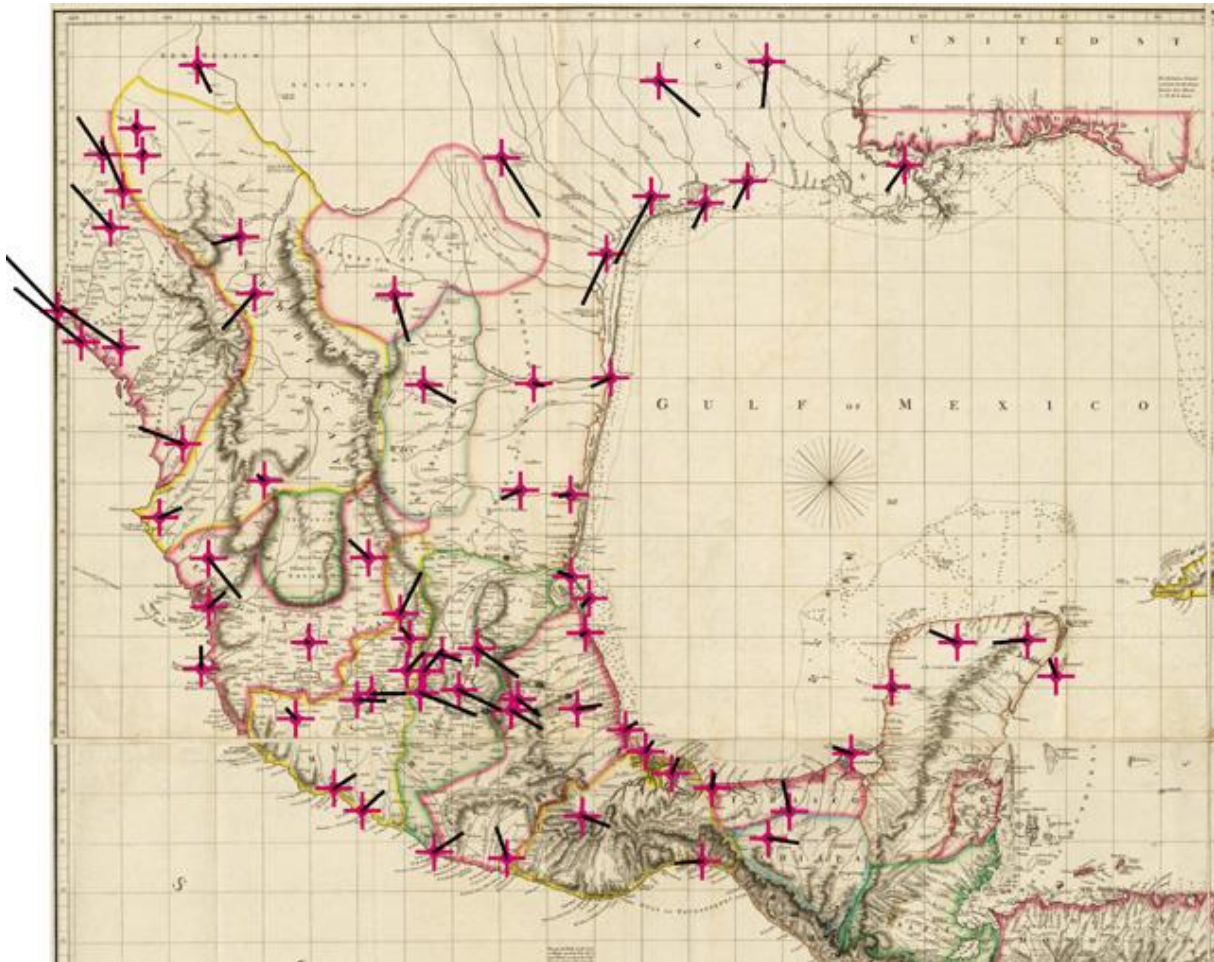


Figure 7: Displacement vectors on Arrowsmith's chart.

A quick review indicates that Humboldt's map is considerably more accurate than those of either of his predecessors in central Mexico, but that positions in other areas do not generally show great improvements, and in a few cases are even worse. There is a considerable resemblance in the patterns of displacements between his map and Alzate's in the northern parts of New Spain. Along most of the coastline, Humboldt's map follows the same patterns as Arrowsmith's chart, and outside of central Mexico and along the coasts Arrowsmith at least vies with Humboldt in accuracy. To understand the significance of these similarities and differences, it is necessary to examine in greater detail how Humboldt compiled the individual parts of his map.

Humboldt's Mapping of Central and Southern Mexico

Unsurprisingly, the displacements revealed by MapAnalyst on Humboldt's map are smallest in central Mexico—especially around the Valley of Mexico, in the areas between Mexico City and the ports of Acapulco and Veracruz, and around the mining districts north of Mexico City (see Fig. 8). These are the areas that Humboldt himself visited in 1803-04, and where he did extensive surveying, including some triangulation and measurement of heights, and where he measured the coordinates of many geographic positions. In addition, this part of New Spain had already been relatively well mapped by

Spanish or Mexican-born (Criollo) surveyors, in addition to Alzate. Humboldt particularly singled out as a source of information Joaquín Velázquez Cárdenas y León (1732-1786), the founder of the School of Mines. Among other things, Cárdenas y León had carried out a triangulation of the Valley of Mexico, and produced a map of Mexico (now unfortunately lost)—both of which were important sources for Humboldt's work.¹⁴

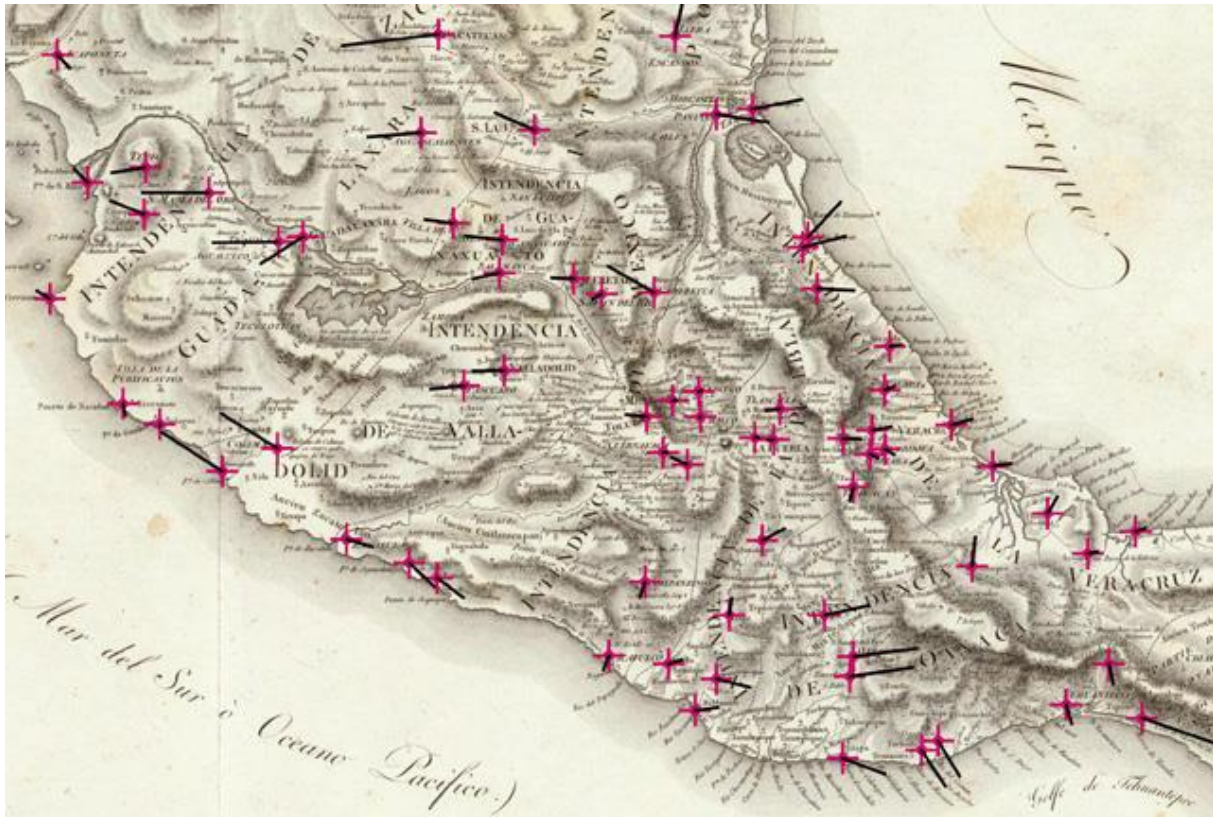


Figure 8: Detail showing displacements on Humboldt's map in Central Mexico.

In spite of its relative accuracy, Humboldt's map falls considerably short of modern standards, even in central Mexico, and especially in the case of longitudes. The latitudes that Humboldt measured himself are almost always very close to the figures accepted today, but his longitudes are generally off by several kilometers—or much more in some cases. This is true even for Mexico City, where Humboldt described his conscientious efforts to measure the longitude and latitude at the Convent of Saint Augustine (later the National Library), which was located near the city's central cathedral and market place (Zocalo). He describes in the "Geographical Introduction" to his *Political Essay on New Spain* the multiple methods he used to determine the longitude of Mexico City, which he "deduced from the eclipses of the satellites of Jupiter, from the distances from the moon to the sun, from transference of the time from Acapulco, and from a trigonometrical operation for estimating the difference of meridians between Mexico and the port of Vera Cruz".¹⁵ In spite of all these efforts, his

¹⁴ "Geographical Introduction," xxiii-xxiv; Orozco y Berra, *Apuntes*, 314.

¹⁵ "Geographical Introduction," xxi.

longitude was off by 2 minutes and 43 seconds (almost 5 km), placing the Zocalo somewhere near the present Mexico City airport.

Although imperfect by modern standards, it should be kept in mind that this measurement was relatively good by the standards of his time. As Humboldt himself showed in his *Carte de fausses Positions* (Fig. 4), in the last half of the eighteenth century widely used figures for Mexico City's longitude were spread out across central Mexico by as much as five degrees (about 550km). Even though Humboldt's measurement is only a slight improvement over one he records as having been made by Valasquez and Gama in 1778, Humboldt's prestige helped assure the use of a relatively accurate figure by most mapmakers in the first half of the nineteenth century.

Humboldt recorded the latitude and longitude measurements that he used in constructing his map in a table of positions at the end of his "Geographical Introduction".¹⁶ This table included both Humboldt's own measurements and those of others in which he had some confidence. Humboldt's own longitude measurements for areas beyond the Valley Mexico, as reported in this table, varied considerably in accuracy. In the case of Veracruz, where he worked with the Spanish astronomer José Joaquín Ferrer (who had an excellent chronometer), his measurement of longitude was off by only 25 seconds. But at Guanajuato he was off by a very substantial 20 minutes and 44 seconds, and at Acapulco he erred by a whopping 46 minutes and 37 seconds.

Most of those positions used by Humboldt in mapping central Mexico, which were taken by other observers, fall within the same range of error, although they often reflect substantial mistakes in latitude as well as in longitude, with individual locations sometimes displaced by as much as 50 or 60 kilometers. Here Humboldt relied primarily on a mixture of manuscript and printed maps by Spanish or Mexican cartographers, along with a number of measurements of longitude and latitude that he thought might be reliable. It is interesting to compare on Figure 7 the displacements for the major cities of Oaxaca and Guadalajara (neither of which Humboldt visited) with those for places where he was actively involved in mapping. It is also noteworthy that Humboldt's own longitudinal measurements are notably better in the vicinity of the Valley of Mexico than in outlying areas he visited, such as Guanajuato or Patzcuaro (where he often used only his chronometer to measure longitudes).

The Mexican Coasts on Humboldt's Map

Turning from central Mexico to coastal areas, we can see several distinctive patterns in the displacement vectors. Much of the Mexican coastline had been relatively well mapped by the Spanish Navy. This applies particularly to the Gulf Coast as far north as the mouth of the Rio Grande, where Humboldt also had at his disposal some very good longitudinal measurements by Ferrer, whose excellent chronometer gave better results than Humboldt had been able to obtain with his own battered timepiece and through his astronomical observations. In spite of some reservations based on Ferrer's work, Humboldt copied this section of his map wholesale from a Spanish nautical chart

¹⁶ Humboldt's table of positions can be found on pages cxxxiv-cxlii of his "Geographical Introduction". Since Humboldt used the Paris meridian, it is necessary to subtract 2° 20' 14" to get the Greenwich figures for purposes of comparison.

published in 1799. As a result, he displaced the coastline several kilometers to the west, as is clearly revealed on Figure 5.¹⁷

Much of the west coast of Mexico had been recently charted by the well-known Malaspina expedition, which started in Acapulco and proceeded up the coast as far as present-day British Columbia. The Malaspina expedition produced maps and coordinates from Acapulco to the southern part of Baja California, which Humboldt incorporated into his map. It also did a good job of mapping the Pacific coast of northern Baja California and present-day California, but these areas were not included by Humboldt on this particular map, although he did use them for the smaller scale map of Mexico and its neighboring countries, which also appeared in his atlas.¹⁸ Apparently the Malaspina expedition did not venture into the northern part of the Gulf of California, for Humboldt copied from its summary map a non-existent island at the head of the Gulf, and the displacements in this area are among the greatest on his map.¹⁹

The Northern Provinces of New Spain

Turning to the upper part of New Spain, including the northern states of present-day Mexico and much of the southwestern United States, the overall accuracy of Humboldt's map deteriorates dramatically. Humboldt himself gave an unvarnished description of the problems he encountered: "In the part of New Spain situated to the north of the parallel of 24°, in the provinces called *Internas* (in New Mexico, in the government of Cohahuila, and in the intendancy of New Biscay) the geographer is reduced to form combinations from the journals of routes. The sea being at a great distance from the most inhabited part of these countries, he has no means to connect together the places situated in the interior of a vast continent, with points on the coast a little better known. Hence, beyond the city of Durango, we wander as it were in a desert, notwithstanding the show of manuscript maps".²⁰

Within this huge area, one can perceive on Humboldt's map distinct patterns in the displacement vectors produced by MapAnalyst, which hint at the sources he used and how he used them. Three geographical areas are worth particular attention: Texas, the corridor from central Mexico to Taos, and another corridor running from northern Sonora to the Gila River in Arizona (see Fig. 9).

¹⁷ For this area, Humboldt relied on *Carta Esférica que comprehende las costas del Seno Mexicano, construida en el Deposito Hidrografico de Madrid* (Madrid, 1799; minor revisions, 1803), available on the World Wide Web from the Biblioteca de Catalunya at:

<http://www.europeana.eu/portal/record/91932/D15F58A72E7DEC356B8210506BE304DFD9ADCD5C.html>.

Humboldt suspected that this chart was inaccurate in part because it disagreed with the observations of Ferrer, but he followed it anyway on his map, although he made a note on the map indicating that Ferrer's observations would place the coast further to the east. "Geographical Introduction", lxxii.

¹⁸ This is his *Carte du Mexique et des pays limitrophes situes au nord* (Paris: F. Schoell, 1811), available from the David Rumsey Collection at <http://www.davidrumsey.com/luna/servlet/s/0ym6vm>.

¹⁹ Humboldt states ("Geographical Introduction", lxxi) that this portion of his map is based on a map published in 1802 by the Marine Depot in Madrid. This would be: Espinosa y Tello, J. *Carta esferica de los reconocimientos hechos en la costa N.O. de America en 1791 y 92 por las Goletas Sutil y Mexicana, y otros buques de S.M. Cardano lo grabo.* 1802., <http://www.davidrumsey.com/luna/servlet/s/i9on52>. This is part of *Atlas para el Viage de las Goletas Sutil y Mexicana al reconocimiento del Estrecho de Juan de Fuca en 1792, Publicado en 1802.*

²⁰ "Geographical Introduction", v.



Figure 9: Displacement vectors for northern New Spain on Humboldt's map.

Texas

Humboldt's portrayal of Texas reflects a strikingly inconsistent mixture of sources. He had fairly good coordinates for the mouth of the Rio Grande and for part of its lower course up to Laredo, as well as for the location of San Antonio. Humboldt complained about the poor charting of the Texas coast east of the Rio Grande, and one can see why, as the section of the coast around Galveston Bay (also copied from the 1799 Spanish hydrographic chart) is dramatically contracted to the west. On the other hand, he did have exceptionally precise coordinates for the mouth of the Sabine River, which later marked the boundary between New Spain and the United States. These he may have obtained from a boundary survey or from a British or American source, although he does not specify where he

got this information. Most of the interior of Texas seems to have been copied from one or more Spanish maps, which were by no means remarkable for their accuracy. The rivers in this area are shown flowing north-south rather than from the northwest, a non-existent lake is shown as the source of the Guadalupe River, and Nacogdoches is wildly misplaced.²¹

The Central Part of Northern Mexico

A different set of problems is presented by the region around Santa Fe, and to some extent all the way along the corridor from Santa Fe to central Mexico. Humboldt's locations in northern New Mexico are shifted in a fairly consistent pattern about 80 kilometers to the north and to a lesser extent to the east. From El Paso to Zacatecas locations are shifted mostly longitudinally to the east by many kilometers.

Humboldt stated that he derived information for this area primarily from eighteenth century Spanish military surveyors, mentioning particularly Pedro de Rivera y Villalón (1664-after 1730), Nicolas de Lafora (ca. 1730 - after 1789), Manuel Agustin Mascaró (1747-1809), and Miguel Costanzó (or Constanzo), 1741-1814.²² These and other military surveyors produced detailed maps of northern New Spain, although Humboldt rightly was skeptical about their underlying distance measurements and the surveyors' determinations of latitude and longitude.²³ Humboldt particularly regarded Costanzó, who he worked with in Mexico City, as a valuable source of information:

The geography of Sonora has been rectified by M. Costanzo. This philosopher, as modest as he is profound, has for thirty years been collecting whatever is connected with the geographical knowledge of this vast kingdom. He is the only engineer officer who has addicted himself to discussions on the difference in longitude of the most distant points from the capital. He has himself formed very interesting plans, in which we may perceive how far ingenious combinations may, to a certain point, supply the want of astronomical observations. I render this justice to M. Costanzo with the more pleasure, as I have seen many manuscript maps in Mexico, of which the scales of longitude and latitude appeared merely as an accidental ornament.²⁴

Costanzó and his colleague Mascaró produced overview maps of northern New Spain, which synthesized and attempted to improve on the work of earlier surveyors. Humboldt singles out a "*Carte manuscrite de la Nouvelle Espagne, dressée au ordre du vice-roi Buccarelli, par MM. Costanzo et Mascaró*". According to Humboldt, "Much care appears to have been bestowed on this work, which has served me for the Moqui [Hopi], for the environs of the Rio Nabajoa [San Juan River], and for the route of the Chevalier la Croix in 1778, from Chihuahua to Cohahuila [*sic*] and

²¹ For more on Humboldt's mapping of Texas see: James Martin, and Robert S. Martin, *Maps of Texas and the Southwest, 1513-1900* (Albuquerque: Published for the Amon Carter Museum by the University of New Mexico Press, 1984), 109.

²² "Geographical Introduction", lxxiii. An excellent introduction to the activities of these engineers is Janet R Fireman, *The Spanish Royal Corps of Engineers in the Western Borderlands, Instrument of Bourbon Reform, 1764 to 1815* (Glendale, CA: Arthur H. Clark Company, 1977).

²³ "Geographical Introduction", lxi-lxii.

²⁴ "Geographical Introduction", lxxiv. For more on Costanzó, see Fireman, *The Spanish Royal Corps of Engineers*, and Jose Omar Moncada Maya, *El Ingeniero Miguel Constanzo. Un Militar ilustrado en la Nueva España del Siglo XVIII* (Mexico City: Universidad Nacional Autónoma de México, 1994).

Texas".²⁵ This and several similar maps have survived, and a visual comparison confirms that they were important sources for Humboldt's map.²⁶

In this part of northern New Spain Humboldt did not improve substantially on the work of earlier Spanish and Mexican cartographers, in spite of his having a better knowledge than his predecessors of the true breadth of the area, as well as possessing his own relatively accurate observations for the longitude of Mexico City. This new information should have enabled him to correct some of the worst estimates of distances and locations on previous maps, and Humboldt describes in his "Geographical Introduction" his extensive efforts to work with these materials to come up with better estimates.²⁷ But, in spite of his efforts, he continued to be influenced by the errors of previous maps, and his final results were not much different. As previously noted, his geographic positions in northern Mexico bear a striking resemblance to those Alzate published nearly 40 years earlier, although it remains an open question to what extent Humboldt was directly indebted to his predecessor, and to what extent both arrived at similar conclusions through the use of the same sources.

Northwestern Mexico

The final area of particular interest in Humboldt's depiction of northern New Spain is what is now northern Sonora and southern Arizona. Here his locations are better placed than they are in most of the other parts of the northern half of his map. Although here too Humboldt probably relied mostly on Costanzó and other military engineers for information, this section of his map is clearly derived, at least indirectly, from different sources than those he used for the route to Santa Fe. Humboldt's depiction of this area is probably largely based, directly or indirectly, on the relatively accurate journal and map made by Francisco Font for the Anza expeditions to California, and possibly also on earlier work by Jesuit missionaries who were active in the area.²⁸

²⁵ "Geographical Introduction", lxxiv-lxxv. Humboldt's bibliographical descriptions are very poor—usually being descriptive titles in French and often lacking author or date information. This particular map is almost certainly a copy of a map by Costanzó and Mascaró now at the General Archive of the Indies entitled *Carta ó mapa geográfico de una gran parte del Reino de Nueva España, comprendido entre los 19 y 42 grados de Latitud Septentrional y entre 249 y 289 grados de Longitud del meridiano de Tenerife, formado de orden del Excmo. Sr. B^o Fr Don Antonio Maria Bucarely y Ursua para indicar la division del Virreinato de México y de las Provincias internas erigidas en Comandancia General en virtud de Reales Ordenes el año 1777* (reference code ES.41091.AGI/26.17//MP-MEXICO,346). A high resolution image of this map can be found by searching the Portal de Archivos Españoles Web site at <http://pares.mcu.es/>. Because it shows the route of the Chevalier la Croix in 1778, it must have been made later than the date tentatively assigned to it by the Archive of 1777. The most likely date for this map, which also includes information from the 1776-1777 expedition into Utah headed by Dominguez and Escalante, is 1779.

²⁶ There are several very similar maps produced by Costanzó and/or Mascaró between 1779 and 1783, all of which synthesize various materials and cover the northern parts of New Spain. For a description of this group, see Carl I. Wheat, *Mapping the Transmississippi West, 1540-1861* (5 v.; San Francisco: Institute of Historical Cartography, 1957-1963), 1:121.

²⁷ "Geographical Introduction", lviii-lxviii.

²⁸ Humboldt cites among his sources the important map by Pedro Font, a Franciscan who accompanied Anza, *Mapa correspondiente al diario que formo el P.F. Pedro Font del viage que hizo a Monterey y puerto de San Francisco* (s.l., s.n., 1777), and the equally important map published by Miguel Venegas for the Jesuits, *Mapa de la California su Golfo, y Provincias fronterizas en el Continente de Nueva España* ([Madrid: En la imprenta de la viuda de M. Fernández, y del Supremo Consejo de la Inquisición], 1757).

It is worth noting that the displacement vectors in southern Arizona and northern Sonora fall into two distinct clusters. The first follows a series of presidios from Altar to Tucson, and shows displacements predominately to the east. The second cluster includes several missions to the south of Arispe, and features longitudinal displacements to the west. This latter area is most likely based at least indirectly on Jesuit cartography rather than on information from the Anza expedition or from military surveys.²⁹

In short, Humboldt's map shows a remarkable amount of continuity in the mapping of northern New Spain with earlier maps going back at least to Alzate, and to some extent even to Sigüenza at the end of the seventeenth century. Although later military surveyors and Humboldt collected additional information and corrected some errors, they did not greatly change the overall framework of the earlier maps. Humboldt greatly reduced the number of place names on the maps of Alzate and Arrowsmith, eliminating many obsolete or minor place names, although also leaving out several fairly important locations. He can at least be credited with adding relatively current information about mines, and presenting his information with great graphic clarity.

Mapping Mountains

Although Humboldt's Map of New Spain is not outstandingly innovative, it does break some new ground in its treatment of relief. Earlier maps of New Spain had at best made rather perfunctory attempts to show relief by drawing little profiles of mountains in areas deemed to be mountainous. With the interesting exception of Arrowsmith, Humboldt is the first to have made a serious effort to depict the topography of Mexico by using a relatively sophisticated system of shaded hachures. He systematically gathered information from manuscript maps and other sources about the position and appearance of mountains, and supplemented it for central Mexico with his own observations, including numerous point elevations taken with barometers.³⁰ Humboldt's work in this regard is best displayed in a detailed map of the Valley of Mexico and in geological cross sections, which he published separately in his atlas, but the mountains of central Mexico are quite recognizable in the depiction on his general map (Fig. 10).

As one would expect, Humboldt was less successful in portraying the topography of the parts of Mexico that he had not visited, and he admitted that he was "far from regarding this part of my work as perfect".³¹ A comparison of Humboldt's map with a modern relief map of Mexico shows only vague resemblances in many areas. It is notable that Humboldt shows the Sierra Madre as a single mountain chain, rather than differentiating clearly between its eastern and western ridges. Humboldt knew that two parallel chains of mountains existed, and they even appear on Arrowsmith's 1803 map. Here his depiction may have been affected by a pet theory that the mountains of the western Americas were a single chain that continued from the Andes to the far north.

²⁹ For early cartography of this area see Mirela Slukan Altić, "Missionary Cartography of the Tarahumara with Special Regard to the Map of Ivan Rattkay, *The Portolan* 86 (Spring, 2013), 36-49. Some acerbic comments on Humboldt's use of Jesuit maps can be found in Ernest J. Burrus *La obra cartográfica de la Provincia Mexicana de la Compañía de Jesús, 1567-1967* (2 v.; J. Porrúa Turanzas, Madrid, 1967), 1:81-83, 216.

³⁰ Humboldt describes the procedures he followed in some detail in "Geographical Introduction", lxxxv.

³¹ *Ibid.*



Figure 10: Detail of Humboldt's map showing mountains near Mexico City.

Conclusions

What is the significance of all of this? If nothing else, Humboldt's vicissitudes underline the difficulty of mapping large and poorly explored areas as late as 1800. It is doubtful if anyone under the circumstances could have produced a better map of New Spain. In spite of recent technological improvements, such as the introduction of the chronometer and better instruments for triangulation, there remained numerous obstacles to producing geodetically accurate maps of lightly populated and poorly explored areas, some of which in this case were dominated by hostile Indians. Humboldt and his contemporaries knew theoretically how to produce much better maps, but the Spanish government lacked the resources to carry out a triangulation, or even to implement more careful route surveys, or to ascertain with greater certainty the longitudes and latitudes of important places in New Spain.

Humboldt's map would have had limited usefulness. Like its predecessors, it served mainly to inform its users of the general location of important places, such as towns, missions, and mines. Its limitations did not stop it from being highly influential. Along with the *Political Essay on New Spain*, it served to draw the attention of colonial administrators, foreign governments, and potential investors to Mexico's resources and potentialities. Its inaccuracies and lack of detailed topographic and road information made it largely useless for such purposes as traveling within Mexico, exploring for mines, or for carrying out military operations on the ground, although some of the more detailed maps in his atlas would have been of some use for such purposes.

This article suggests several avenues for future research regarding both the antecedents and the influence of Humboldt's map. Using MapAnalyst we can compare the locations on sequences of maps

to ascertain in greater detail what sources Humboldt used for the various parts of his map, and also to examine how these sources related to each other. This technique can also be used to study the influence of Humboldt's work on later cartography. As previously mentioned, his map was widely regarded as the best available for Mexico and the American Southwest as late as 1850, although by then parts of it had been superseded both by American mapping in what is now the southwestern United States, and by Mexican mapping in some other areas. Many maps of Mexico published between 1810 and 1850 were based in large part on Humboldt's work, but numerous changes are evident on some of the published maps of the country. The techniques outlined here should enable us to get a much clearer picture of how Humboldt's work was used and modified in the first half of the nineteenth century.