

Spain Honors an Illustrious Geodesist: Jorge Juan y Santacilia (1713-1773)

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In a rare tribute to the science of geodesy, the Bank of Spain has issued a 10,000-peseta note (at current exchange rates equivalent to about \$75) displaying an engraving of Jorge Juan y Santacilia on the reverse side. The geometric diagram shown below his portrait is a partial modernized rendition of a figure which appeared in one of his best-known treatises.

Jorge Juan (1713-73), as his name is commonly shortened, was already a lieutenant in the Spanish Navy and an experienced mariner, well versed in astronomy and mathematics when, at the age of 21, he was appointed by the King to accompany the Paris Academy expedition to measure a meridian arc in Peru. He was joined by one of his peers, 19-year-old Antonio de Ulloa (1716-95). This pairing began an almost fraternal relationship which remained for the rest of their lives. Their commission explicitly stated that Juan was responsible for registering all scientific matters related to geodesy, astronomy and navigation, while Ulloa would concentrate on gathering historical and anecdotal information, including subjects dealing with geography, botany and ethnography of the area. In close partnership they coauthored several important scientific studies, as well as a major sociological review containing eyewitness accounts of the censurable treatment afforded to the South American indigenous population by some unscrupulous Spanish authorities. This lengthy two-volume report (*Noticias Secretas de América*) was classified "top secret" for many years, until it was leaked and published for the first time, in its entirety, in London in 1826.

Interacted With Pierre Bouguer

As a consequence of this assignment in Peru, Juan and Ulloa subsequently interacted and cooperated with other well known geodesists such as Pierre Bouguer, Charles-Marie de La Condamine and Louis Godin. However, even at their young ages, the two Spaniards were direct participants in the arduous work of designing, reconnoitering and observing the required geodetic triangulation which spanned a yet-uncharted mountainous wilderness.

The geodetic and astronomic measurements took place in the so-called *Virreinato de Perú*, which belonged to Spain when the project was planned. For this reason Louis XV of France asked Philip V of Spain for his authorization and support for this unprecedented international scientific enterprise. The Spanish

monarch not only immediately granted the request but, in a philanthropic spirit, named the two young Royal Navy (*Real Armada*) officers to accompany the members of the expedition and actively participate in the observations. The royal order issued by the Madrid court that granted permission to the French scientists to enter Spanish America, dated August 1734, specifies: "Two Spanish subjects knowledgeable in mathematics and astronomy, so that they can assist the Frenchmen in all the observations which they may make, and take note of those which they observe themselves."



Though historically it is referred to as the "Peru Expedition," the region where the observations were performed is now located inside Ecuador.

Many books and scholarly papers have been written detailing the scientific accomplishments and the various vicissitudes surrounding this expedition. The geodetic part of the

work was carried out with great difficulty, owing to the peculiar topography of the terrain. Since several triangulation points were placed on high snow-capped peaks, the observers suffered greatly from the cold while waiting days, or even weeks, for the low clouds to lift before they were able to carry out their trigonometric observations. On several occasions, rumors circulated that one or more members of the expedition had died as a consequence of the severity of the elements. In fact, after one especially violent storm, public prayers were offered for their souls. The expedition seems to have suffered, too, from the frequent unreliability of the natives, who in critical circumstances abandoned their camps and left the scientists duly engaged in their "mysterious" objectives. Rumors spread among the local inhabitants accusing the foreign visitors of prospecting for rich minerals and precious stones.

Leaders Quarreled With Each Other

All in all, there was very little cordiality or guidance from the leaders involved in this endeavor. This was further worsened by the arrogant behavior of two of them in particular, Bouguer ("the theoretician") and La Condamine ("the practitioner"), who frequently quarreled and remained "mortal enemies" afterwards. The three Paris academicians and the two Spaniards performed much of their work independently, even publishing the final results and conclusions separately. However, it is only fair to point out that each individual displayed an admirable scientific zest, which sustained them in the unfavorable conditions of the equatorial jungles on the one hand and the Andean summits on the other. Even today we owe all of them, as a unit, gratitude for the hardships they endured while helping to solve the ambiguous question of the size and shape of the Earth.

Juan and Ulloa were also forced to be away from the primary geodetic operations for extended times. In 1740 the Viceroy of Peru drafted their services to organize the naval and coastal defenses of the province, which was under potential attack by the English. This purely military involvement took several months to complete, after which they were free to rejoin the French scientists. However, in December 1741, they were recalled to Lima once more to secure it against the threat of English Vice Admiral Anson. By the time they were able to return to Quito, the French had

left, Juan and Ulloa finished their geodetic work alone, extending the network northward by completing five new triangles.

The compilation of all observations and results connected to this venture by Juan and coauthored by Ulloa was originally published in 1748 under the title "Astronomical and physical observations made by order of His Majesty in the Kingdoms of Peru from which it is deduced the size and figure of the Earth and its applications to navigation." Following a preliminary discourse, which consisted of a recount of previous opinions and investigations about the figure of the earth, all observations

made in Peru and subsequent calculations were enumerated, and then the expected conclusion that the earth was a flattened ellipsoid was presented. This technical contribution was accompanied by a set of four volumes describing the full experience, which became very popular, attaining worldwide dissemination. Its title is a long one, "Historical relation of the trip to Meridional America made by order of H.M. the King to measure a degree of terrestrial meridian, to help expand the knowledge of the real figure of the earth, also containing other astronomical and physical observations." The account of their ordeal was

reprinted seven times at various European capitals (Paris, London, Amsterdam and Dublin) before Juan's death.

Going back to Juan's life, it should be mentioned that he became an orphan at the age of three and was raised under the intellectual patronage of his paternal uncle. After rigorous tutoring in mathematics and the humanities, Juan was also inducted into the military Order of Malta when he was only 13 years old. He returned from Malta to Spain in 1730 and registered for the elite Naval Academy in Cadiz. During the next four years while a cadet, he traveled extensively to Italy, North Africa and, on one occasion, almost died after an intoxication which was traced to the provisions of one of the Armada supply ships and which cost the lives of 500 seamen.

One of the Most Educated Mariners

After completing his studies, the Peruvian sojourn kept him engaged for the next 11 years, alternating between scientific and military activities. Once back in Spain he was promoted to captain in the Spanish Navy, and was chosen to be a member-correspondent of the Paris Academy of Sciences, London's Royal Society and the Berlin Academy. He was a recognized naval engineer who held influential administrative positions in the government. His efforts were pivotal in revamping and modernizing the Spanish shipyards. He was named director of his beloved alma mater, the Naval Academy, creating a prestigious visiting chair that was awarded to his old colleague and mentor in Peru, the academican Godin. Juan was a prolific writer. He produced substantial works that were translated into several languages, some of them published posthumously. He was considered one of the most educated mariners in Europe and was affectionately known as the "Spanish sage." The culmination of his political career was realized with his nomination as Spanish ambassador to Morocco six months before his death.

And what about Ulloa? He returned to Peru as governor of one of its provinces and later married a Peruvian lady. He is credited with the discovery of platinum. He became a member of the academies of London, Paris and Sweden. He was also the first Spanish governor of Louisiana after a treaty with France transferred that colony to Spain.

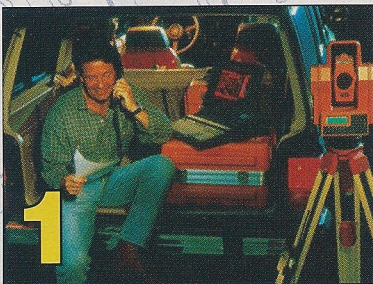
Finally, a note for numismatic collectors. Current plans call for an end to the currencies of the countries belonging to the European Community (EC). It is expected that Spain will adopt the new monetary unit, the euro, and, consequently, all prevailing bills and coins will surely be taken out of circulation. ■

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