

IN RAINIER'S FOOTSTEPS: JOURNEY TO THE CHIVOR EMERALD MINE

Robert Weldon, Jose Guillermo Ortiz, and Terri Ottaway



Figure 1. In Colombia's Sinaí Valley, the sandstone monolith of El Pulpito hangs from a steep cliff in the top right. The Chivor mine is just out of view above the rock. Photo by Robert Weldon/GIA.

In early 2015, our team climbed a steep trail on the eastern range of the Colombian Andes, making the ascent toward the legendary Chivor emerald mine. A string of mules carried our packs, enabling us to bend to the task of the steep climb. We were retracing the steps of Peter Rainier (box A), a brilliant mine engineer with a lust for travel and adventure. Rainier took over the Chivor mine in 1926 and returned it to prominence. He later wrote a book about his experiences, titled *Green Fire*.

As we clambered along, our gaze took in stark red coral trees blazing in full bloom, framed against a lush green landscape. We were looking for El Pulpito—"The Pulpit"—a massive rock jutting out from the mountains. Suddenly, its unmistakable silhouette came into full view ahead of us (figure 1). This classic landmark of the Chivor mine hung precariously over the Sinaí Valley as birds of prey glided by. Our visit to Colombia's most venerable emerald mine, which has produced some of the world's finest emeralds (figure 2), had begun.

PREPARATIONS FOR THE JOURNEY

In 2013, two of the authors were reflecting on Rainier's book and his adventures in search of Colombian emeralds. During the discussion we con-

See end of article for About the Authors and Acknowledgments.

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Figure 2. This emerald on apatite is from the Klein pit at Chivor. Photo by Robert Weldon/GIA, courtesy of the Natural History Museum of Los Angeles County.

sulted John Sinkankas's encyclopedic *Gemology: An Annotated Bibliography* (1993). Sinkankas's assessment of *Green Fire* was decidedly mixed:

Written in colorful, sometimes sensational terms, this work was not seriously regarded as an authentic record of modern emerald mining at Chivor, Colombia, until recently.... Nevertheless, the effort is worth it and [there are] many solid "plums" in the pudding from which solid conclusions can be drawn as to what really happened, the methods of mining employed, geological formations encountered and their significance insofar as bearing emeralds is concerned, specific knowledge of emerald occurrence, crystals found, methods of recovery, cleaning, and other data of interest and value.

Further investigation of the archives at GIA's Richard T. Liddicoat Library revealed a long-forgotten

Rainier file and an album of black-and-white photographs, many of which identify him as the photographer. The images of Rainier and the mine workers, the mountainous landscapes, and the terraced mines at Chivor, as well as negatives showing impressive emerald crystals, are pieces of a provocative story that is all but lost to history. Sinkankas had purchased the album during the 1980s and added it to his personal library, which was acquired by GIA in 1989. Sinkankas also referenced Rainier's scholarly articles about Chivor in his own extensive writings about emeralds.

We decided on a new voyage to Chivor, in part to experience firsthand the challenges he might have faced. In March 2015, two of the authors, accompanied by four Colombian locality experts (please see the Acknowledgments), several pack mules, and a four-wheel-drive vehicle, embarked on a six-day expedition (figure 3).

This article spotlights the fabled Chivor mine of Colombia and its unique emeralds through Rainier's observations, archival photos, and the authors' findings. To place his story in the proper context, the article begins with an overview of the Spanish conquest of Colombian emerald territories, focusing on Chivor, and the ensuing global trade in emeralds. Finally, it leads to the rediscovery of the mine, up to the start of the Rainier era.

EMERALD CONQUESTS IN COLOMBIA

Before the time of the conquistadors, emeralds from sources such as Egypt's so-called Cleopatra's Mines and Austria's Habachtal deposit had long been established in the Old World. The discovery of New World emeralds completely upended the world's understanding of and appreciation for the gem. When Hernán Cortés entered modern-day Mexico in 1519, he received emeralds from Montezuma as gifts (Prescott, 1843). Spaniards throughout the conquered territories forcibly extracted information from the indigenous peoples regarding the emerald source, but details remained elusive for decades.

The Spanish originally assumed the source was in Peru, where emeralds were abundant among the Incas. In 1532 Francisco Pizarro captured and held for ransom the Inca emperor Atahualpa, in the region that came to be known as Peru. From the Incas Pizarro extorted gold and other items of value. An astounding treasure-filled room—containing mostly gold and silver, but also some emeralds—was assembled to free the emperor. Atahualpa was executed despite the delivered ransom, but details of the

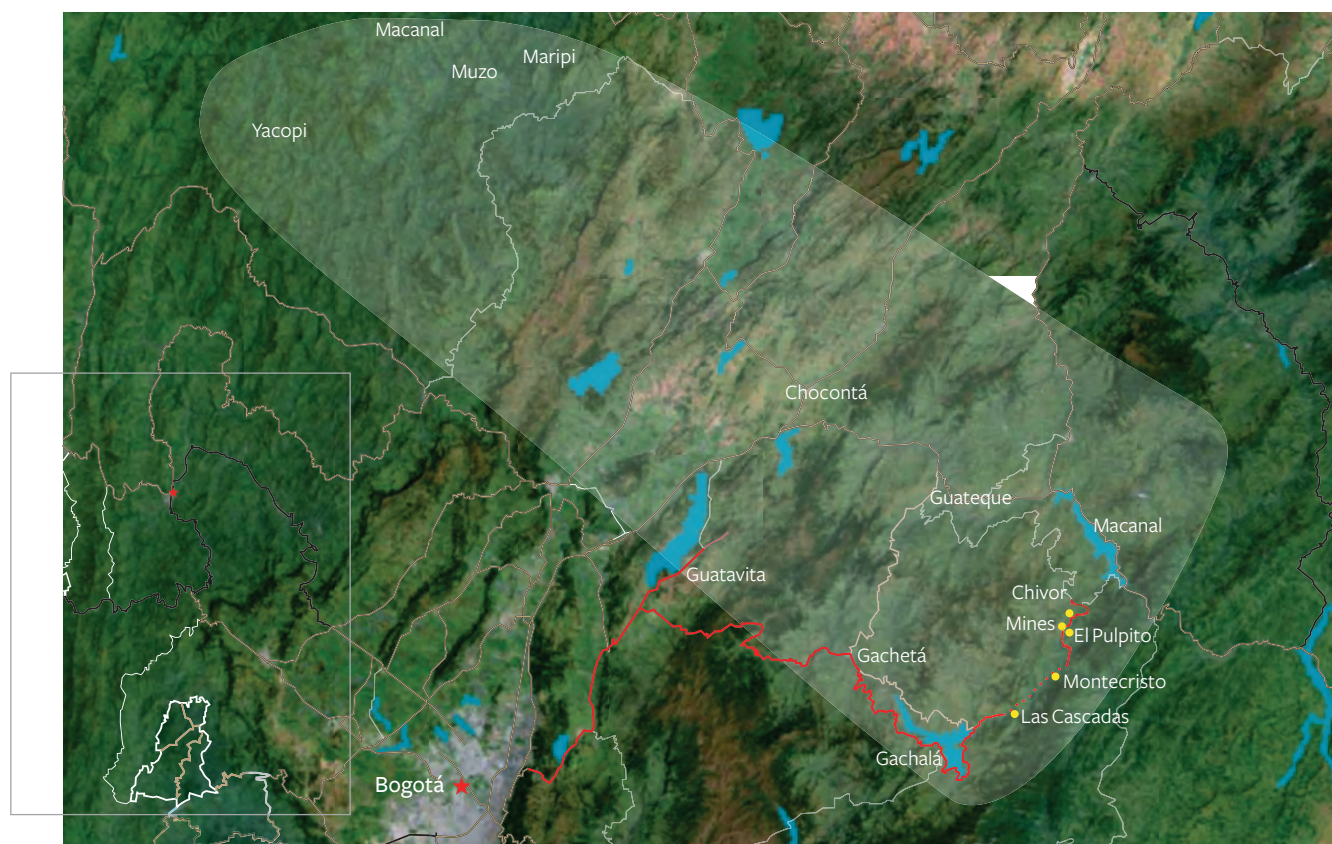


Figure 3. The Colombian Andes are the source of many historic emerald deposits. Chivor lies on the eastern side of the Eastern Cordillera, about 180 km by car from Bogotá. The authors drove from Bogotá, via Lake Guatavita, to the famed emerald deposit at Gachalá. From there they drove to Las Cascadas, the site of Peter Rainier's tea plantation and home. The rest of the journey was accomplished on foot and by mule, wandering down the Guavio Valley past Montecristo and on to Chivor. This map shows the Colombian "emerald belt," a northwest-to-southeast emerald-rich zone in the Eastern Cordillera that encompasses Muzo, Cosquez, Chivor, and Gachalá.

treasure fascinated the Spanish. In 1536 the Spanish queen issued an order to find the emerald source (Lane, 2010).

Spanish conquistador Gonzalo Jiménez de Quesada reached the Eastern Cordillera of the Andes in 1537. In this area, a territory he would later call Nueva Granada, the Spanish were actively looking for emeralds and other treasures, particularly as they began to see many more emeralds worn by the native Chibcha (figure 4). Quesada founded Bogotá in 1538 (Azanza, 1990).

Friar Pedro Simón chronicled Quesada's discovery of the first emerald source in his treatise *De Las Noticias Historiales de Las Conquistas de Tierra Firme las Indias Occidentales* (1565). He described how Quesada finally obtained the whereabouts of an emerald deposit called "Somondoco," named for the nearby village where emeralds were sorted by the Chibcha (Pogue, 1916). The Somondoco deposits

would become known as "Chivor." Having located some mineralized emerald veins, Quesada sent his

Figure 4. Bogotá's Museo del Oro contains notable gold and emerald jewelry worn by the Chibcha. Photo by Robert Weldon/GIA, courtesy of Museo del Oro.



BOX A: PETER W. RAINIER (1890–1945)



Peter W. Rainier was a descendant of British admiral Peter Rainier (1741–1808), after whom Mt. Rainier in Washington State is named. Born in Swaziland in 1890 in the back of an ox wagon, he later attended secondary school in Natal. His parents had migrated to South Africa from Great Britain in the late 1800s, during the Transvaal gold rush (P.W. Rainier Jr., pers. comm., 2015). During his youth he traveled extensively throughout South Africa, Mozambique, Rhodesia (present-day Zimbabwe), and Nigeria. In later years, while in Colombia, he recalled growing up in Africa in books such as *My Vanished Africa* and *African Hazard*.

Following World War I, Rainier moved to Milwaukee, Wisconsin, where he married Margaret Pakel. He was hired by a New York-based consortium, the Colombia Emerald Development Corporation, to restart operations at the abandoned Chivor emerald mine. Rainier moved there in 1926, and his family joined him two years later.

Green Fire, a memoir chronicling his adventures, was published in 1942, long after his departure from Colombia. It became a literary success, and MGM eventually licensed his book for a 1954 movie of the same title but only a vaguely similar plot, starring Grace Kelly and Stewart Granger. His descriptions of the firm that hired him are veiled and generally unfavorable, though he had turned Chivor into a very profitable mine during his time as manager between 1926 and 1931. An undated Colombian newspaper clipping from GIA's Rainier archives describes production from the mine: "10,000 carats of Emeralds Reach the Capital: Yesterday, the administrator of the Chivor mine reached Bogotá, bringing with him a huge quantity of first-rate emeralds, the majority of them *gotas de aceite*." This term, Spanish for "drops of oil," is often used in the trade to designate high-quality emeralds (figure A-1; see also Ringsrud, 2008).

With Margaret, Rainier also established South America's first commercial tea plantation at Las Cascadas, set on a high slope in the Guavio Valley. His family and the plantation held Rainier's attention during downtime at the mine, or when bandits temporarily overran the concession. After Margaret succumbed to illness in 1938, Rainier abruptly lost interest in Colombia (P.W. Rainier Jr., pers. comm., 2015). He departed for Egypt, where he eventually remarried. Since Rainier's departure, the historical landmark has fallen to ruin.

Like his namesake, Peter Rainier had a distinguished military career. He fought in both world wars—in Namibia (then South-West Africa) against the Germans in World War I, and with the British Army Corps of



Figure A-1. This Chivor emerald and diamond bib necklace contains 36.02 carats of emerald briolettes, 18.34 carats of step-cut Chivor emeralds, and a 5.03 ct center diamond. Photo by Robert Weldon/GIA, courtesy of Pioneer Gems.

Royal Engineers against Field Marshal Erwin Rommel's forces in World War II. One of Rainier's feats was the construction of a freshwater pipeline, which he tested with salt water. Rommel's troops overran the position to control the water supply, but upon drinking the salt water, over a thousand Germans surrendered at El Alamein ("A drink that made history," 1943; "Major Rainier's water line..." 1944).

Details of these feats were included in another one of his books, *Pipeline to Battle*. His engineering skills in North Africa earned him the nickname "The Water Bloke." Rainier achieved the rank of major with the British Eighth Army and was posthumously awarded with the Order of the British Empire, Military Division.

Following his military service, while the war was still being fought, Rainier toured North and South America, lecturing and raising funds for the British war effort. In 1945, while traveling in Canada to report on a mining property, he was severely burned in a hotel fire in Red Lake, Saskatchewan. He died from his injuries in Winnipeg on July 6, 1945. A military funeral took place in Toronto, and his remains were buried at Flagler Memorial Park in Miami.

captain, Pedro Fernandez Valenzuela, and 40 men to investigate. Simón describes the moment:

Following much work, some [emerald crystals] of all kinds, good and not so good, were extracted. Understanding that a greater number of workers and instruments were needed to properly work the veins, [Valenzuela] returned to Turmequé to tell the general all about his findings, and to relate about the great [plains of the Orinoco River] that he had discovered from the heights of the mines, which could be seen through an aperture in the Sierras, towards the east, or where the sun rises. The general was duly impressed.

In 1537, the town of Tunja was conquered, and nearly 2,000 emeralds were seized (Sinkankas, 1981), suggesting that emeralds from Somondoco were being traded among the Chibcha. It is now known they were in fact traded with other cultures for hundreds of years—as far north as Mexico with the Aztecs, and to the south with the Incas. Chivor is singled out by historians as the source of the first emeralds traded in the Americas, and the first to be exported to the rest of the world following the Spanish conquest.

With the discovery of Muzo a year later and production beginning around 1558 (Sinkankas, 1981), Nueva Granada became the world's most important emerald source. The quantity of goods finding their way to Europe was so large that prices temporarily dropped (Ball, 1941). Colombian emeralds were initially greeted with some suspicion on the continent, perhaps because there was such a sudden influx of them, or because they were deemed too good to be true. One author (de Arphe y Villafañe, 1572) claimed that the new ones were worth only half the price of their Egyptian counterparts.

Despite these initial misgivings, the emeralds from Chivor and later Muzo were impossible to ignore. The crystals were often large, with a profoundly saturated green color—so superior to Egyptian and Austrian emeralds that those ancient deposits were destined to fall out of favor (figure 5). Emerald fever took hold of the conquistadors. In Nueva Granada, the Spanish heard of a legendary place called Guatavita, where a man coated in gold dust was ceremonially immersed into a round mountain lake. It was said that emeralds and gold objects were tossed into these waters as offerings to the Sun God, known as El Dorado. This legend only fueled the Spaniards' search for treasure.

As emeralds from Chivor began to be exported to Europe, the conquistadors took local chieftains prisoner and held them for ransom to extract the locations of other mines and the legendary El Dorado. Local



Figure 5. In the 16th century, Colombian emeralds such as these approximately 15 ct doubly terminated hexagonal crystals began to redefine quality standards for the gem. Photo by Robert Weldon/GIA, courtesy of Museo de la Esmeralda.

populations were enslaved to mine for emeralds.

At Chivor, a 20 km aqueduct, built from rock with Spanish engineering and Chibcha slave labor, was used to bring water to the mine. The water was gathered in holding ponds called *tambres*, while the mining took place along the steep hillsides. After the emerald veins were exposed and the gemstones were carefully extracted, the *tambres* were opened, allowing the sudden rush of water to wash mining debris and overburden downhill (Johnson, 1961).

THE EMERALD TRADE

Spain was the principal importer of Colombian emeralds, though most did not stay there and surprisingly few emeralds remained in the royal treasury (Sinkankas, 1981). It is generally accepted that emeralds entering Spain were dispersed throughout the continent, mostly in trade for gold, which was the most liquid of assets. In short, plunder from the New World helped build Spain's treasure fleet and ultimately the Spanish Armada, further enabling Spain's imperial ambitions (Lane, 2010). Principal buyers of the emeralds were European royalty, clergy, and aristocrats.

In Europe, Colombia's emeralds appeared in jewelry trading and manufacturing centers such as Amsterdam and London. The Cheapside Hoard in the Museum of London, containing treasures concealed during the Elizabethan era, includes as its centerpiece a 17th-century emerald watch. The large hexagonal

emerald containing the watch movement is identified as from Muzo. It would have arrived in London in the early 1600s, scarcely 50 years after the discovery of that Colombian source (Forsyth, 2013).

Emeralds were also traded for other commodities in the Far East (figure 6): textiles, spices, pearls, and other gems. It is believed that emerald commerce was often clandestine, as its high value was concealed in small packages that could be easily transported (Lane, 2010).

On the other side of the Tordesillas line, which effectively divided South America between Spain and Portugal, the Portuguese did not find emeralds in Brazil. They searched for several centuries, with little to show (Weldon, 2012). But emeralds from Colombia were exported by Spain as far away as Goa, India, where the Portuguese flourished (figure 7). According to Jacques de Coultre, one of the European merchants who traded in the area in the late 1500s and early 1600s, “It is very true that all parts of the world send pearls, emeralds, rubies and jewels of great value to East India and everyone knows full well that they ended up in the hands of the Great Mughal” (Vassallo and Silva, 2004).

Figure 6. The 75.45 ct Hooker emerald possesses an exceptional bluish green color and clarity that are often associated with the finest emeralds from Chivor. Once owned by Abdul Hamid II, who reportedly used it as a belt buckle, the emerald was acquired by Tiffany & Co. in 1911. It was refashioned as a pin and is now part of the National Gem Collection at the Smithsonian Institution. Photo by Robert Weldon/GIA, courtesy of the Smithsonian Institution.



Figure 7. The Maharaja of Indore necklace (also known as the Spanish Inquisition necklace) has resided in the Smithsonian's National Museum of Natural History since 1972. The center emerald (approximately 45 ct) and the barrel-shaped emeralds from Muzo and Chivor were cut in India in the 17th century. They are accented with Indian diamonds from Golconda. Photo by Robert Weldon/GIA, courtesy of the Smithsonian Institution.

Colombian emeralds were particular favorites of the Mughal rulers during the 1600s, such as Jahangir and Shah Jahan, who amassed gem treasures of incalculable value (Dirlam and Weldon, 2013). Many of these jewels—and the largest known single collection of emeralds—ended up in Persia, in present-day



Figure 8. This Mughal emerald (front and back views) incorporates a floral motif inlaid with gold and Golconda diamond accents. An inscription is barely discernible. From Colombia the gem made its way to India and was fashioned during the Mughal era. Photo by Robert Weldon/GIA, courtesy of Dhamani.

Iran (Meen and Tushingham, 1969). Important emeralds were skillfully carved with floral motifs and inscriptions from the Koran (figure 8).

Emeralds recovered by treasure hunter Mel Fisher from the Spanish galleon *Nuestra Señora de Atocha* in 1985 offered insight into how emeralds were exported from the New World. The *Atocha*, which sank off the coast of the Florida Keys in 1622, was part of a fleet that left port from Cartagena, bound for Spain via Havana. The ship was loaded with silver and gold ingots as well as loose emeralds and emerald jewelry, items that were detailed on its manifest. The ship's course and the type of cargo it carried revealed the supply chain of emeralds destined for Europe and Asia via Spain (Kane et al., 1989). During the colonial period, this trade would last the better part of two centuries (figure 9).

The first recorded mine concession at Chivor went to Francisco Maldonado de Mendoza in 1592 (Lane, 2010). A year later, realizing that the Chibcha were being exterminated, Spain issued a royal decree regarding humane treatment of the miners. In 1602 King Philip III demanded that the laws be enforced, but it was already too late: The Chibcha labor force had been almost entirely decimated. Muzo, which had been worked since around 1558, promised a much richer volume of production.

After a few more decades of sporadic mining, the concessions at Chivor were finally deserted in 1672, following an order by Spain's Carlos II to close the mine (Sinkankas, 1981; Macho, 1990). Over the next two centuries, the abandoned workings were over-



Figure 9. The cross pendant and chain pictured here are part of the wreckage of the *Nuestra Señora de Atocha*, which sank in 1622 en route to Spain. Courtesy of Eileen Weatherbee. From left to right: a 422 ct emerald crystal from Cosquez, courtesy of Roz and Gene Meieran; a collection of elongated crystals from an unknown mine, courtesy of Ron Ringsrud; and the 982 ct Angel of the Andes (far right), one of the largest emerald finds from the Chivor region, courtesy of Roz and Gene Meieran. Photo by Robert Weldon/GIA.

taken by jungle. With Chivor shuttered, the principal focus shifted toward Muzo (Ringsrud, 2009). A timeline of important events in Chivor's history is shown in figure 10.

REDISCOVERY OF CHIVOR

Colombian mining engineer Francisco Restrepo had researched legends about the lost mines of Somondoco in the late 1880s, visiting the national library to gather information from its archives. His research yielded Friar Simón's extensive account, forgotten for almost two centuries. Friars were often paid in gold or emeralds after a conquest and therefore had

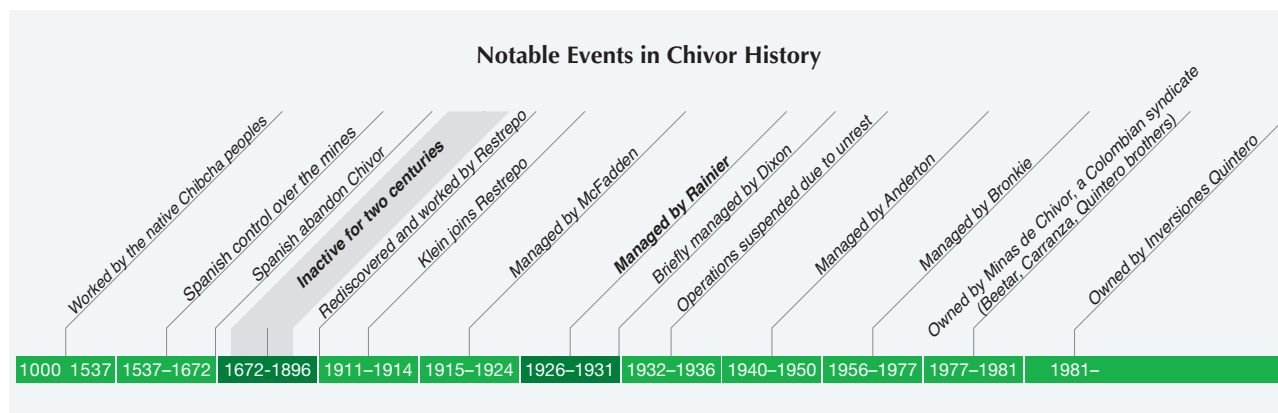


Figure 10. Rainier's time at Chivor was brief in the history of one of the longest-running gem mines in the world. Chivor's two centuries of dormancy, after the Chibcha and Spaniards abandoned the claims, stand in stark contrast with its otherwise productive life.

unique insights into these commodities. Simón's perceptions were later detailed in a series of volumes. Similar reports came from the writings of another friar, Pedro Aguado. Based on those early descriptions of the location, Restrepo spent about eight years searching the Eastern Andes before finding the lost mine in 1896 (Rainier, 1942; Johnson, 1961; G. Ortiz, pers. comm., 2015).

Restrepo did as many miners do: He diversified, controlling concessions at Chivor, which were not overseen by the Colombian government (a peculiar consequence of the 1593 royal order). By the early

1900s, Restrepo also had interests in the government-owned Muzo mine. He worked both mines for a dozen years, earning him great respect in the annals of Colombian mining. In 1911, Fritz Klein came from Idar-Oberstein to join him. Klein's connections with the Colombian president allowed him to travel freely through many of the emerald mining regions, a privilege few foreigners could claim. The tales of his adventures and emerald mining at Chivor with Restrepo are related in his 1925 book, *Smaragde Unter dem Urwald (Emeralds Under the Jungle)*, the first extensive account of the mine (figure 11).

Figure 11. Fritz Klein wrote the first detailed account of the Chivor mine, which includes the hand-painted plate by Walter Wild on the left. The plate shows typical Chivor emerald presentations, such as the rare hollow crystals on the top right, called *esmeraldas vasos* ("emerald cups"), courtesy of Dieter Thomas Klein. The *esmeraldas vasos* from Chivor on the right weigh 14.19 carats total. Photo by Robert Weldon/GIA, courtesy of Museo de la Esmeralda.

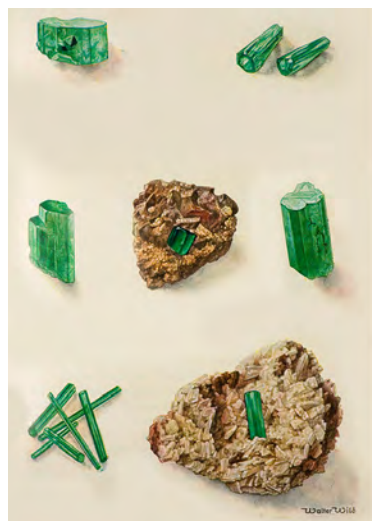




Figure 12. Left: Justo Daza, pictured here next to an extension of the Spanish aqueduct, is one of the most famous emerald miners in Chivor's history thanks to his discovery of the Patricia emerald, a 632 ct colossus that resides at the American Museum of Natural History. Courtesy of Gonzalo Jara. Right: An illustration of the Patricia emerald, from Fritz Klein's *Smaragde Unter dem Urwald*, courtesy of Dieter Thomas Klein.

Klein left Colombia around 1914 to fight for Germany in World War I, but he later returned to oversee mining operations for Restrepo. In January 1921, a mine worker named Justo Daza (figure 12, left) uncovered what seemed to be a productive vein and pocket. Klein recalls immediately reaching into the vein "up to his elbow" and pulling out small albite, apatite, and quartz crystals. Reaching in farther, he closed his hand over a large object, which he withdrew and immediately put in his pocket without looking at it. "If what is in my pocket is an emerald, I will have fulfilled my contract," he told a colleague (Klein, 1925).

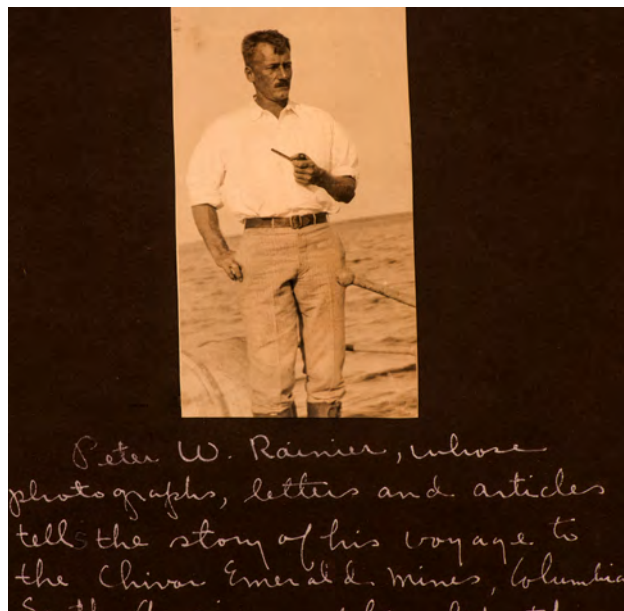
The doubly terminated hexagonal crystal that emerged from his pocket was the 632 ct Patricia emerald (figure 12, right), now housed at the American Museum of Natural History in New York City. For his part, Daza is said to have received about \$10 (Keller, 1990). Chivor had intermittent mine managers after this, most notably C.K. MacFadden and W.E. Griffiths.

THE RAINIER ERA

Perched on a slope overlooking the Sinaí Valley, the emerald deposits at Chivor cling to Colombia's eastern Andes. In the deep valleys 1,220 meters below, the confluence of the Rucio and Sinaí rivers forms the Guavio River, which help frame the Chivor deposits. Shortly after his arrival in 1926, Peter W. Rainier planted an iron stake into El Pulpito at the

edge of the Chivor concession. From this vantage point, he commanded a view through a gap in the Montecristo range before him. He gazed into the distance at the *llanos*, the grassy flatlands of the Orinoco River delta (figure 13).

Figure 13. Because he was usually the photographer, portraits of Peter W. Rainier are rare. Beneath this photo, he began writing an essay on his years at Chivor. Courtesy of P.W. Rainier Jr.



"Andean scenery is deceptive. So huge in its conception, that one could drop an ordinary mountain range into one of its great valleys," he later wrote in *Green Fire*. "The Chivor mine was the only point in the inner Andean ranges of the district from which the *llanos* of the Orinoco could be seen, and that distant view had provided the only clue to the rediscovery of the mine..."

The iron marker reaffirmed the locality's boundary, abandoned since Francisco Restrepo had worked the claims in the late 1800s and early 1900s. For Rainier, it was also symbolic, marking the beginning of his emerald mining odyssey (Rainier, 1942). Laying claim to Chivor is but one of the challenges many have faced in mining emeralds from this mountaintop locality. The engineers and geologists who grapple with finding "green fire" at Chivor must deal with the logistical challenges of this steep and highly inaccessible locality (figure 14), which some have described as "vertical real estate" (Johnson, 1961).

Getting themselves and their equipment to the remote location, transporting emeralds out of Chivor safely, finding suitable food, battling malaria and yellow fever (Rainier, 1942), and occasionally dealing with poisonous snakes, jaguars, and caimans in the rivers were their daily concerns. Then there were the arduous tasks of obtaining good, trustworthy labor and dealing with unpredictable roving bandits. There was no town of Chivor in those early days, so mine provisions, food, and equipment had to be brought in across the Andes by horse.

In addition to those physical challenges, Rainier had to deal with the demands of his employer, the Colombia Emerald Development Corporation. The company's executives had no idea about the difficulty of mining emeralds at Chivor. They expected him to find the mine and bring it into production immediately. But in addition to reopening the mine, clearing the debris around it, learning a new language, and hiring mine workers, Rainier had to actually locate the mineralized veins and start producing emerald. After hiring local Chibcha and toiling for weeks to build the mining infrastructure, he received a cable from his employer: "As the mine still continues to operate at a loss, the Board has regretfully decided to close it down as the funds to its credit in Bogota are exhausted. You will reserve sufficient of these funds to reimburse you for the unexpired portion of your six months' contract..." (Rainier, 1942).

Rainier decided to ignore the cable, and within a week his foreman announced the discovery of the



Figure 14. Workers clear jungle and prepare terraces along the mineralized zones. Courtesy of P.W. Rainier Jr.

first emerald vein. Rainier (1942) described them as "tiny hexagonal crystals, the dark green of still water and with the green a trace of blue" (figure 15).

Rainier had a way of galvanizing the workers, inspiring them to redouble their efforts (figure 16). He

Figure 15. A miner at Chivor holds up *chispas* (sparks), the name given to small hexagonal emerald crystals with a vivid color and a hint of blue. They are often indicators of larger emeralds in a vein. Photo by Robert Weldon/GIA.





Figure 16. Left: During Rainier's time, workers pried open mineralized veins using long iron bars, and the work was done along terraces in an open-pit setting. For environmental reasons, most mining now takes place in underground tunnels, using jackhammers. Photo courtesy of P.W. Rainier Jr. Right: Rodrigo Rojas, a miner at Corte de los Gavilanes in Chivor, takes a break from the difficult underground work in the carbonaceous black shale. Photo by Robert Weldon/GIA.

told the crew that they had only “caught the tail of the tiger” and that an even greater reward awaited the person who found the first marketable emerald. After Rainier cabled back the success of his finds, the company announced a six-month extension of his contract, giving him time to actually bring Chivor into production. About two months later, a veteran miner named Epaminondas, who had worked for Francisco Restrepo two decades earlier, uncovered a much richer vein. Such a find required discretion, as a highly valuable vein could be emptied out overnight.

Epaminondas “lifted one prehensile foot, sole upward for me to see,” Rainier wrote in *Green Fire*. “Between the first and second toes was a glimpse of green. I held up my open palm and an emerald fell into it. If I live to be a hundred I shall never forget that stone.”

Very soon the Chivor mine was fully terraced along its steep sides, and the emerald veins were systematically exposed (box B).

In 1929, Rainier published an article for mining engineers titled “The Chivor-Somondoco emerald mines of Colombia,” in which he disclosed Chivor’s production (in carats) during his time there. In it Rainier highlighted an upward trend in quantity and quality (color 1 being the best, color 5 a pale green),

which he believed spelled a bright future for the mine:

YEAR	Color 1	Color 2	Color 3	Color 4	Color 5	Total
1926	0	3,170	400	11,500	28,400	43,470
1927	0	4,592	11,936	15,554	5,443	37,525
1928	0	505	10,668	4,299	7,240	22,712
1929	200	4,985	10,135	0	120	15,440

Emeralds from Chivor began showing up in world markets. News of Rainier’s successes traveled quickly, inevitably making its way into Colombia’s underworld. “[T]he revolver in full view of my hip tended to discourage anyone from being too inquisitive about the contents of my saddle wallets,” Rainier wrote in *Green Fire*. “This was a method of carrying valuables that I followed throughout my four years at Chivor, four years in which I was to carry enough valuable emeralds into Bogotá to seriously disturb the equilibrium of the world’s emerald market.” *Green Fire* devotes an entire chapter to “Joaquin the Bandit,” who first tried to dispute the legality of the company’s claim at Chivor. Once the legal matter subsided, the battle for control of the mine turned violent.

In 1931, at the height of production—with a total of 46,250 carats produced (Sinkankas, 1981)—Rainier



Figure 17. These miners defended Chivor from armed bandits. Chris Dixon stands fourth from the left, with his two sons on either side. Peter Rainier is on the far right. Courtesy of GIA.

lost control of the mine. Not because of the bandits, though they returned later, but because his employers unexpectedly closed the mine, just as promising new emerald veins were being uncovered. With the American stock market crash of 1929, many investors' funds were drying up, as was consumer interest in buying the gems.

Having to vacate the mine at such an auspicious time was a sad moment for Rainier. As he feared, Joaquin and his bandits moved in on Chivor. Rainier, with veteran emerald miner Chris Dixon and his two sons, ultimately drove out the bandits during a nighttime raid, using guns and dynamite, even though the mine was no longer under his control (figure 17). In fact, Rainier began working the Muzo deposit under separate contract in 1933 (Sinkankas, 1981). In a wry touch, Rainier dedicated *Green Fire* in part to "Joaquin the bandit, who challenged me to a duel and was the most evil man I ever met." Rainier responded by proposing that the duel take place in a crowded marketplace using bricks at five paces. The bandit, outwitted, dropped the challenge. Again and again, Rainier skillfully outmaneuvered Joaquin, who constantly sought to ambush and kill his sworn enemy.

Rainier describes one tense standoff: "For a long time Joaquin and I stood breast to breast, while his Adam's apple oscillated violently. Then he moved

back slightly. I followed at once. If he should ever attain a distance from me I was sunk. Once his revolver was out of the reach of my hand he would have me at his mercy."

According to his son, Peter W. Rainier Jr., "After my father retook Chivor from the bandits, he went back to help run the mine while my mother looked after Las Cascadas. They would communicate each night by 18-inch flashlights, as the Chivor peak was across the valley, 15 kilometers down the Guavio River. That way he could reassure her he was okay."

His wife Margaret's death precipitated Rainier's departure from Colombia in 1938. Chris Dixon and a succession of others managed Chivor after Rainier. Russ Anderton, who had previously worked in Ceylon and India as a gem buyer, was on-site briefly in the early 1940s. He wrote a book about his own adventures in Ceylon and Chivor, titled *Tic Polonga* (1953). Chivor in the 1940s and 1950s had not changed appreciably since the Rainier era. Manuel Marcial de Gomar, a Florida-based jeweler specializing in Colombian emeralds who worked at Chivor as an interpreter for Anderton, noted that horses were still required. So were weapons. Marcial de Gomar recalled that there were government-issued revolvers for those working the district.

"When you stopped at an inn after a day of travel,

BOX B: THE HUNT FOR EMERALDS

Lightning seldom strikes in the same place twice, let alone hundreds of times. The odds facing an emerald miner are equally daunting. Gem minerals are notoriously difficult to find, especially those *in situ* rather than in secondary sources (figure B-1). Even when they are discovered, only a tiny fraction (0.01 %) have the superlative color, size, and transparency to be used in magnificent jewelry (Sinkankas, 1981).

Emerald is arguably the most elusive of the legendary gems. Emeralds are typically found associated with pegmatites in Brazil, Zambia, Austria, South Africa, Zimbabwe, Pakistan, and Russia (Kazmi and Snee, 1989). These coarse-grained rocks are carriers of beryllium, the key component of emerald. Knowing this association gives the emerald miner an edge when determining where to explore and where to mine. In contrast, the emeralds found in Colombia occur in black shales and limestones rich in organic matter, without the benefit of pegmatites to point the way (Keller, 1981; Ringsrud, 2009).

Colombia's emerald-producing region stretches from the Muzo, Cosquez, Yacopí, and Peñas Blancas mining areas in the western zone of the Eastern Cordillera to the Chivor areas in the eastern zone. In both zones, emeralds occur within alternating beds of limestones and shales. Mineralization is limited to certain strata where it occurs in veins in the folded, fractured sediments (Oppenheim, 1948; Anderton, 1950; Sinkankas, 1981; Banks et al., 2000).

At Chivor, emeralds are found sporadically within thin albite-pyrite veins that run parallel to the bedding of the sediments. There is rarely any indication that a particular vein may produce (figure B-2). With any luck, one might encounter small pieces of the pale green opaque beryl known as *morralla*. But even the presence of *morralla* does not guarantee that gem-quality emerald will be encountered farther inside the vein. If it is, "a single emerald vein can yield anywhere from a few grams up to

Figure B-1. Emeralds in matrix, measuring 11.88×10.06 cm, from the Chivor mining district. Photo by Robert Weldon/GIA, courtesy of Museo de la Esmeralda.



Figure B-2. An emerald vein is pried open by hand so as not to break the valuable crystals. Photo courtesy of Gonzalo Jara.

6,000 grams of fine emerald crystals—a king's ransom" (Rainier, 1929, 1942).

The productive strata, which lie in the Cretaceous Guavio formation, are at least 1,000 meters thick (Johnson, 1961; Sinkankas, 1981; Keller, 1981). Peter Rainier was an experienced mining engineer with a skill for reading the rocks. He noted that within the productive strata there are three horizontal "iron bands" about 50 meters apart and up to 1 meter thick that delineate the emerald zones (figure B-3). The bands are comprised of weathered iron oxides (limonite-goethite) along with pyrite. Emeralds occur predominantly in the beds below the second and third lower bands. During Rainier's time, 75 % of the emeralds mined came from below the bottom iron band, which is 30 to 182 meters thick (Rainier, 1929; Johnson, 1961). Guided by these observations and noting the subtle changes in texture between the productive strata before it bottomed out to barren strata, Rainier was able to make Chivor a profitable producer of fine emeralds once again (Rainier, 1942).

Using production figures and his knowledge of how much rock had been removed, Rainier calculated the ratio as 16 cubic meters of rock per carat of emerald (1 carat = 0.2 gram). Renders (1985) and Renders and Anderson (1987) took the next step, using Rainier's figures to calculate the amount of beryllium in solution required to precipitate the beryl/emerald yield. The numbers show that the solutions were not as rich in beryllium as once thought. An extremely low beryllium concentration of 10^{-7} (0.0000001) moles per kilogram of solution would account for the quantity of emerald estimated to occur in a vein space of 5,000 cubic meters. Analysis of the organic-rich black



Figure B-3. This photo of the main workings at Chivor was taken by Peter Rainier in 1930. It shows the mountainside laid bare and terraced, with groups of miners using long steel rods to remove dirt, hoping to find elusive emerald veins. Once the gems were removed, a tambre was released to wash debris downhill, a technique employed by the Spanish using Chibcha aqueducts. Rainier described the location of the emerald zone, which is denoted by the red "X." Courtesy of P.W. Rainier Jr.

shales showed 3 ppm on average, more than enough to produce the observed quantities of beryl (Beus, 1979).

There is a strong regional and local association between emerald deposits and evaporites (Oppenheim, 1948; McLaughlin, 1972; Banks et al., 2000). Evaporites produced by the evaporation of seawater form large beds and salt domes of gypsum (hydrous calcium sulfate) and halite (sodium chloride). Their significance becomes apparent when one examines the fluid inclusions in emerald. Halite crystals (figure B-4) are a common component pointing to the high salinity of the emerald-forming solutions (Roedder, 1963; Kozlowski et al., 1988; Ottaway, 1991; Giuliani et al., 1995).

We now know that emeralds in the Colombian deposits, from Chivor to Muzo, formed from hot evaporitic brines at 330°C. In key areas, these brines reacted with organic matter in the shales. The subsequent thermochemical process of sulfate reduction oxidized the organic matter to carbon dioxide, releasing organically bound beryllium, chromium, and vanadium (Ottaway, 1991; Ottaway et al., 1994; Giuliani et al., 1995). The resulting pressurized solutions were forced into fractured shales and limestones, where they precipitated albite and emerald. Hydrogen sulfide generated during the sulfate reduction process combined with the available iron to precipitate the large amounts of pyrite, including the now-weathered iron bands, found in the emerald-producing areas. This latter step was critical, because removal of iron from the hydrothermal system meant that it could not be incorporated into the emerald. This allowed the chromophores

chromium and vanadium to impart the beautiful blue-green color and provide an underlying red fluorescence (unquenched by the presence of iron) that makes the material's color so luminous (Nassau, 1983).

The remarkable consistency in the geology of Colombian emerald deposits and in the fluid inclusion composition suggests that the hydrothermal systems at work operated under favorable structural settings (fault zones) and associations of evaporites and organic matter (Beus, 1979; Ottaway, 1991; Ottaway et al., 1994; Branquet et al., 1999). While the possibility of more Chivors and Muzos waiting to be discovered is tantalizing, they are relatively tiny targets in the steep, often inaccessible terrain.

Figure B-4. Three-phase fluid inclusions of halite, water, and carbon dioxide are typical of Colombian emeralds. Photomicrograph by Nathan Renfro; field of view 0.91 mm.

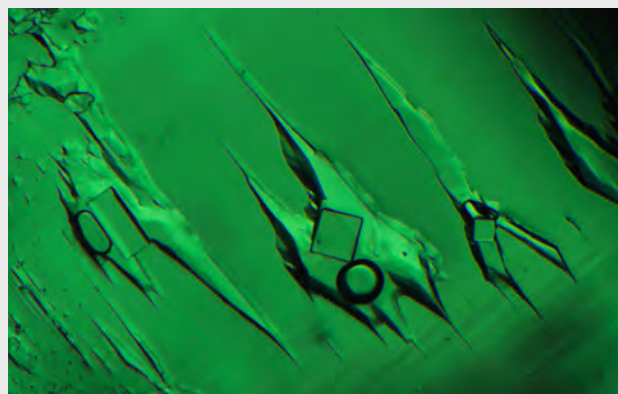




Figure 18. Willis F. Bronkie on his way to Chivor, circa 1950. Photo courtesy of Gonzalo Jara.

it was important not to get the room above the bar," Marcial de Gomar said. "If there was any revelry in the bar, those who shot in the air were liable to kill the guest above."

Another notable resident at the mine was Willis F. Bronkie (figure 18), who became the appointed trustee of Chivor Emerald Mines in 1956 and ran the company until the early 1970s. Peter Keller, a noted expert on Colombian emeralds, asserted that Rainier and Bronkie were Chivor's two "famous superintendents" and credited Bronkie with saving the Chivor mines from bankruptcy in the 1950s (Keller, 1981).

While two main mining sections remain, named Chivor 1 and Chivor 2 by Restrepo, a multitude of smaller claims have sprung up along either side of the Sinaí Valley. There is no accurate count of these independent claims today. Current production figures remain unknown, as distrust among the claimholders pervades. Independent observers suggest that because there are so many other mines throughout Colombia, Chivor only accounts for about 10% of the country's total output (Morgan, 2007). According to emerald dealer Gonzalo Jara, "Chivor has been producing, over the past ten years, a flow of emeralds which fluctuates between dry, very small quantities to occasional high yield times. In this sense, one could state that Chivor is a constant producer, year by year, but how much? Nobody knows."

At the main emerald market, Bogotá's Calle Jiménez, and at the offices and cafés around the emer-

ald district, industry veterans examine crystals that materialize from dealers' pockets and declare their brightness and bluish traces to be "typical" of Chivor's emeralds, though there is no actual proof. Emeralds from Chivor continue to enter the market, but with the 2013 death of Muzo emerald czar Victor Carranza (at one time a part owner of Chivor) and mine owner Victor Quintero's death in 2015 and the ensuing disposition of the mines, production has remained consistently low.

THE ROAD TO CHIVOR

Getting to Chivor nearly a century after Rainier (figure 19), we experienced far easier travel conditions—and no bandits. From Bogotá we drove about 120 km east past Gachetá to Gachalá. Both regions have emerald concessions, though this was not known in the 1920s. Our group then began ascending the Andes past La Vega de San Juan, site of arguably the finest emeralds ever found in Colombia. One such gem was the 1967 find of the Gachalá emerald, a superb 858 ct gem crystal eventually donated to the Smithsonian Institution by jeweler Harry Winston. Rainier would have traveled this route or a similar one, passing through the communities of Guateque and Chocontá by a grueling combination of train, truck, and horseback (figure 20).

We descended increasingly rocky terrain toward the settlement of Palomas at the entrance to the Guavio Valley, past emerald workings. Our immediate destination was Las Cascadas, Rainier's estate and tea plantation (figure 21). The team walked the high mountain paths of the great Guavio Valley. Climbing from the main road toward the compound took 45 minutes but offered spectacular views of our ultimate destination: the mines at Chivor, approximately 15 km away. It is easy to see why the valley would have enthralled Rainier, a natural wanderer and explorer. Mountain rifts in the valley contain magnificent trees with flowering bromeliads, and waterfalls often cascade for hundreds of meters:

Their music was in our ears that first night I spent with my family in the rough camp in the forest, and it remained as an accompaniment to our every action during the years we lived there. *Pianissimo* when the falls were mere feathery wisps in the dry season, a roaring crescendo when the rains of the wet season lashed the peaks above and the mountain torrents leaped from the terraces in solid columns of water (Rainier, 1942).

The compound was imposing nearly a century ago, the only place with electricity for hundreds of kilometers. Taking advantage of the abundant hydroelectric



Figure 19. A panoramic view of the principal mining claims at Chivor in 2015. Photo by Robert Weldon/GIA.

power for daily needs and the farm, Rainier installed a water turbine. Las Cascadas, the first tea plantation in South America, was administered by Mrs. Rainier.

Rainier describes journeying from Las Cascadas to Chivor, dawn to dark, negotiating steep Andean ascents, raging rivers, and slippery rock paths on his fast horse, Moro. It took us twice that time walking in the *dry* season, accompanied by a trio of slow-footed but willing pack mules.

The vertiginous paths down the Guavio Valley led us under a thundering waterfall and toward Montecristo, a hamlet at the border of Cundinamarca and Boyacá provinces. At nightfall we reached Montecristo and familiarized ourselves with the two-dollar-a-night accommodations. Members of the team agreed this was probably overpriced. The structure was composed of wooden planks held together by hope and covered by deeply rusted sheets of tin roofing. Unbe-

Figure 20. Left: Transportation through the Chivor region was by horse or mule. Photo by Peter W. Rainier, courtesy of GIA. Right: The authors follow Rainier's path from Las Cascadas to Chivor on foot and by mule. Photo by Robert Weldon/GIA.





Figure 21. Left: The only known photo of Las Cascadas, Rainier's home and tea plantation, was taken in the 1950s, not long after Rainier's departure. Courtesy of Dustano Martinez. Right: In 2015, Las Cascadas was a crumbling shadow of its former self; the large tree at the center of both shots forms a reference point. Photo by Robert Weldon/GIA.

knownst to Rainier, who had walked or ridden past Montecristo for a decade, fine emeralds were to be uncovered in the ravines and faults in the range above the town. Small independent mines have since been started there (I. Daoud, pers. comm., 2015).

A fresh pack of mules assisted the team as we made our way along a steep trail, finally reaching a hanging bridge over the Rucio (figure 22), barely a stream in the dry season. Chivor was within reach.

CONCLUSION

In researching this story, it became clear that much of the region's history is forgotten. Most of the his-

tory would have been lost entirely had it not been for *Green Fire* and the photographs taken by Rainier, which helped mark a productive and colorful era in Colombian emerald mining.

Rainier's struggles to find the elusive emeralds, and bring them successfully to market, is a timeless mining saga. He did this while battling natural and manmade challenges, ultimately achieving an epic triumph over adversity.

Chivor's once bountiful emeralds may have taken a back seat in terms of today's production, but the mine has a tendency to surprise with its sudden, spectacular revivals. Chivor emeralds' unique bright color,



Figure 22. This hanging bridge over the Rucio, built by Rainier, marks the crossing from Cundinamarca Province into Boyacá, very close to Chivor. Photo by Peter W. Rainier, courtesy of GIA.



Figure 23. During his brief time at the Chivor emerald mine, Peter Rainier restored the fortunes of this legendary source. His memoir, *Green Fire*, illustrated the challenges of mining there and the timeless allure of its green gems. This platinum, emerald, and diamond necklace contains 23 emeralds from Chivor totaling approximately 45 carats. A combination of step-cut and round brilliant diamonds, weighing approximately 22 carats total, complements the design. Photo by Robert Weldon/GIA; necklace courtesy of Ronny Levy, Period Jewels, Inc.

tinged with blue, and their relative lack of inclusions are attributes that fascinate global aficionados (figure 23). These emeralds captivated Rainier's attention in the 1920s and 1930s, and in turn he helped change the modern world's appreciation for the source.

Before leaving Chivor for the journey back to Bogotá, we took a day hike from the base of the Sinaí Valley along a very steep incline to El Pulpito. Undoubtedly that natural landmark will remain to guide future explorers, should the Andean jungle

once again overtake the mine. On this day, we were trying to find the iron bar sunk into the rock by Rainier. It had disappeared, but the hole where it had been plunged was eventually found under a layer of dirt and grass. It was a moving discovery, an echo of Rainier's accomplishments nearly a century earlier. From the high point at El Pulpito, seeing emerald country spread before us, we enjoyed a moment of quiet contemplation. Peter W. Rainier is long gone. But at El Pulpito, his presence was felt.

ABOUT THE AUTHORS

Mr. Weldon is manager of photography and visual communications and is based at GIA's library in Carlsbad, California. Mr. Ortiz is a mechanical engineer and emerald dealer who owns Colombian Emeralds Co., based in Bogotá and Los Angeles. Ms. Ottaway is a geologist and curator of the GIA Museum in Carlsbad.

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Our investigation, with help from genealogist Gena Philibert-Ortega, led us to Rainier's son. Peter W. Rainier Jr., also an author, was living in Canada and working on his latest book at the age of 89. Through his sharp memory and comments, we were able to attach names to long-forgotten faces in unmarked photos and piece together details about his father that had been left untold. We profoundly thank him.

Emerald dealers and mine owners Don Victor Quintero, Ismael Daoud, Favio Navoa, Enrique Figueroa, Misael Díaz, Alberto Sepulveda-Sepulveda, and Osbal Yovany Martínez were crucial to

our visit. Although they did not know Rainier, these gentlemen provided information and stories about Chivor and Muzo and allowed us to photograph their emeralds. Gonzalo Jara supplied additional historical images and background. In California, Bill Larson opened his library to us and provided emerald specimens for photography. The Smithsonian Institution in Washington D.C. and the Natural History Museum of Los Angeles County allowed us to photograph and use images of some of their prized emerald objects.

Victor Castañeda, an emerald dealer from Gachalá who had been to several of the Rainier locations in the Guavio Valley, confirmed the locations in Green Fire.

Experts from Bogotá, Gachetá, Gachalá, and Chivor—Victor Castañeda, Pedro Alvaro Angel Urrego, Alfonso Cuervo, and Fernando Niño Murcia, respectively—ensured safe passage through emerald country. We also relied on the kind help of experts, locals, and total strangers as we walked and rode our mules across the Guavio Valley.

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For More on Peter Rainier and Chivor

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