PEDERNEIRA!

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The Pederneira Mine

São José da Safira, Minas Gerais, Brazil

Dedication

This article is the culmination of nearly 14 years of work with the Pederneira mine and with the people who live and breathe the project every day. The Pederneira mine partners, the Oliveira Rocha family, the miners, the cooks, the groundspeople, the security people, the caretakers, geologists, drillers—in short, every single person who has done a job, big or small, which has helped us attain our goal—I dedicate this to all of you. Without your continued collaboration and belief in our project, the Pederneira mine would have been closed long, long ago. Thank you all for sharing with me (and the world) your culture and this amazing mine with all its incredible treasures.

Thanks also to Wendell Wilson and Tom Moore for their detailed editing of the text; to Wendell Wilson for the graphic design; to photographers James Elliott, Jeff Scovil, Joe Budd, Federico Picciani and Adalberto Giazotto for their fine specimen photography; to Federico Picciani for preparing some of the drawings; to my team at Fine Minerals International, without whom this work could never have been completed; and thanks, of course, to my wife Marisa, without whose support and input the Pederneira rollercoaster ride (and others) would not have been possible.

Daniel Trinchillo

***Frontispiece*: Tourmaline multiple scepter, 10.3 cm, from the Rocket Pocket, Pederneira mine. James Elliott photo; Fine Minerals International specimen.**

The Pederneira Mine

São José da Safira, Minas Gerais, Brazil

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Tourmaline, 28 cm, nicknamed "Bi-Color Steel," the finest specimen known from the Pederneira mine. James Elliott photo; Fine Minerals International specimen.

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Frontispiece: **South America as it was in 1850 (Pederneira mine location added). From *Geographicus* (by John Tallis).**

Introduction

The Pederneira mine in Brazil qualifies as one of the world's greatest tourmaline occurrences. Discovered in the early 1940s, it has been intermittently producing large numbers of world-class tourmaline specimens in a stunning array of colors and color combinations since the late 1990s. Recent geological studies and exploratory drilling may have revealed new productive ground.

It was a fateful day in early 2000 when I was shown a photo—mind you, just a 4 × 6-inch print—at my home in Whitestone, New York. At 26 years old, I was in my eighth year as a professional mineral dealer. The photo was of a tourmaline specimen recently recovered at the Pederneira mine in Brazil. It was handed to me by long-time mineral dealer Michel Jactat, who was visiting me at my parents' home on his way back from a two-month tour of Brazil. The photo knocked my socks off!

The dialog went like this:

Daniel: "WOW!"
Michel: "I know."
Daniel: "Did you buy this piece? Where is it?"
Michel: "Well you know it's complicated . . . it is reserved and possibly sold but there could be more in the future so we will wait and see."
Daniel: "Is it sold or not?"
Michel: "I don't know for sure . . ."
Daniel: "Let's find out now!"

Figure 1. **The snapshot of the 17-cm "Sharon Stone" tourmaline specimen first seen by the author in 2000. José Menezes photo.**

This specimen, later nicknamed "Sharon Stone" by the mine owners, was among the first indications of the long series of spectacular specimens that Pederneira would produce in the years following. This is where my adventure began. Persistently I begged Michel to go back to Brazil and to buy the lot of tourmaline that included this piece. He insisted that he had been away for over two months already and that he just could not return, he needed to go home to his wife and family. So I said "I'll go!" and I pressed him to call the owner of the specimens and find out if I could come to visit them. Michel called a number from the phone in our kitchen and I began speaking with José Menezes de Sousa (many know him simply as "Ze" or "Menezes"). José said that the lot had already been sold, but was not yet paid for. So I asked whether, if the deal could not be closed for any reason, I could make a second offer. When he said "Sure, I guess so," I told him "Okay, great, I'll see you within 48 hours!"

Up to this point in my life as a mineral dealer I had totally ignored Brazil as a source of specimens. I started my business in Russia and the republics of the former Soviet Union, and in the early 1990s I began dealing in minerals from China; up to this point I had focused on those areas. They were complicated places to work, but there was little competition from other Western dealers, and therefore much opportunity. Brazilian mineral specimens, on the other hand, had been exploited for over half a century already, and I thought that I wouldn't be able to compete against the already well-established collectors and dealers. But when I saw this photo I threw caution to the winds and immediately booked a flight for Rio de Janeiro and onward to Belo Horizonte.

I had talked on the phone with Menezes on a Sunday. It took me a day or two to get a visa, but by Wednesday I was landing in Belo Horizonte. Michel had arranged for a driver to meet me there, and it turned out that this driver, Marcello Valadares, was also a local mineral dealer who lived in Governador Valadares. He greeted me with a nice smile and began driving me to his home city. The ride took nearly seven long hours, so it was after dark by the time we arrived in Governador Valadares. Although I could hardly wait to see the material, I had to be patient until the next morning.

I barely slept, dying to see those extraordinary tourmalines, but at the same time I knew that my chances of obtaining them were slim. The pocket was already spoken for, and I knew that I prob-

Figure 2. **The "Sharon Stone" tourmaline, 17 cm, from the pocket of the same name. James Elliott photo; current owner unknown.**

ably wouldn't even get to see it. Nevertheless I met Menezes at his office and began learning about the mine and its production. I was shown the tourmaline specimen whose photo had made me get on a plane to Brazil, but unfortunately it was wrapped up like a basketball with paper and tape: "sealed" in the way that Pakistani dealers seal specimens. I was totally crushed that I wouldn't even be able to see the piece, even though it was right in front of me!

All was not a total loss, though: Menezes and I hit it off and began a freewheeling discussion of mining and mining projects. I learned that there were five partners in the Pederneira mine—José Menezes de Souza, Wilson Tomich, Saint-Clair Fonseca Jr. ("Keké"), Eustacio Neves and José Miranda Da Costa Jr.—and that their current arrangement was with Colorado dealer Bryan Lees of Collector's Edge Minerals. Although I fully expected that I had no chance, I waited three days just to make sure that the deal with Collector's Edge went through. It did, and the tourmalines went off to Colorado.

Surprisingly, and luckily for me, Bryan's focus turned out to be solely on the tourmalines; no one was paying much attention to two other specimens from the mine, large quartz crystal groups with no associated tourmaline to speak of. These specimens had come out just before the Sharon Stone Pocket was found, and they are outstanding. So, unable to buy the lovely tourmalines, I took the two quartzes as a fine consolation prize. We negotiated rather quickly, and in the end I was very pleased to have made a first deal with the Pederneira partners.

Location

The Pederneira mine is located in the state of Minas Gerais, which directly translates to "General Mines." There are hundreds of mines in the state, which is quite large and located centrally in the country. Minas Gerais is rich in mineralization, especially in its very widespread pegmatites.

Reaching the mine is relatively simple. The journey begins with a flight to Rio de Janeiro or São Paulo, then a flight to Belo Horizonte and finally one to Governador Valadares. From that city you have a three-hour drive north-northwest through some moderate off-road terrain, passing by the town of São José da Safira, the Aricanga mine, the Cruzeiro mine and the tiny town of Cruzeiro before finally reaching the gates of the Pederneira mine.

For about the last 50 km the road is unpaved, and the driving experience is filled with bumps, cattle crossings and occasionally landslides. There is an old airstrip which was created during the earliest period of mining at Pederneira; we used to use it occasionally to reach the mine quickly or to fly out valuable specimens rather than risk driving them out and being hijacked along the roads. Nowadays, when we need to reach the mine quickly or to bring specimens out, we charter a helicopter.

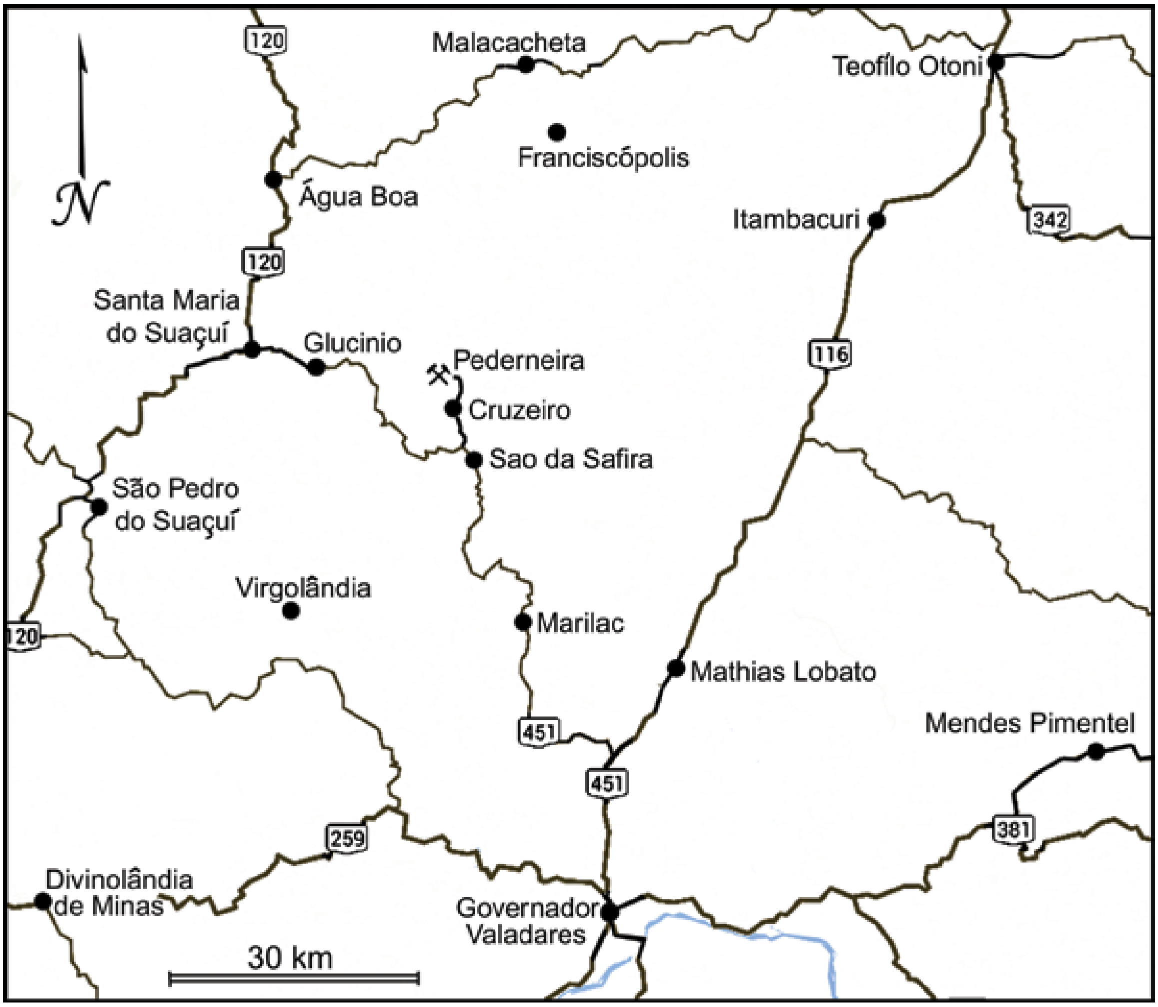


Figure 3. **Location map.**

***Figure 4*. Ridge-top airstrip and dirt road leading down to the Pederneira mine.**

***Figure 5*. Small private plane landing at the Pederneira airstrip, following a 25-minute flight from Governador Valadares. Marco Lorenzoni photo.**

***Figure 6*. Road sign on the way to Cruzeiro, beyond which is the Pederneira mine. Daniel Trinchillo photo.**

***Figure 7*. Free-range cattle are common in the area. Marco Lorenzoni photo.**

Birth of the Partnership

When I first began working with the partners in the mine it seemed obvious to me from my discussions with Menezes and the others that the productive history of the Pederneira mine was just beginning. Exploitation (at least in the currently working area) had only begun some eight months earlier, in the fall of 1999. A pocket which had been discovered before the Sharon Stone Pocket was more significant in many ways, and had led to the formation of the current partnership. Before joining the project, all of these men had been mineral and gem dealers specializing either in specimens or in cut stones or both, and all had prior histories with one another. But however unlikely the partnership (known as the "M. Pederneira Limited") seemed at first, it turned out to be quite successful.

It all began with a local miner named Dada, who had once worked in the original lower adit of the two current adits or "tunnels" at Pederneira (more soon about that original adit, called Dilo's Tunnel). While prospecting on the hill about 100 meters above the older workings, Dada discovered a new outcrop of pegmatite. The adit driven into this outcrop would later become known as "Dada's Tunnel," or, translated literally from the Portuguese, "Dada's Service." Dada and his sons began by making a simple road up the side of the hill and using hand tools to dig into the mountainside. Eventually, to follow the strike of the pegmatite, Dada needed more equipment. His friend Eustacio Neves (one of the Neves brothers, all of whom were involved in mining projects across Brazil) had the needed equipment and also had a relationship with the landowner, José Oliveira Rocha (or "Deca" as he is known by all), who maintained the mining rights. Dada decided to ask Eustacio to partner up with him to work on the new tunnel.

So the initial partnership was made up of these three men: Deca, Eustacio and Dada. They began working the new tunnel and exploiting the pegmatite. A small but outstanding pocket of tourmaline discovered there toward the end of 1999 (now referred to as "Keké's Pocket") brought the Pederneira mine into the public eye as a major producer of some of the finest tourmaline specimens the world has ever seen, as well as some fine gem rough. Not only did this pocket lead to almost a decade and a half of continuous, still ongoing mining; it was also the beginning of one of the few mining projects in the world where the main goal has been to retrieve specimens for the collector rather than just to produce ore or gem rough.

No one really knows for sure, but it appears that the entire contents of "Keké's Pocket" were stolen without the knowledge of the three partners. The material ended up in the hands of a local dealer named Domingo, who took it all to Governador Valadares, the nearest major city and a hub of the local gem and specimen trade. There, Domingo looked up Saint-Clair Fonseca Jr., affectionately known to all as "Keké," who, with his brother, owned shares of the Aricanga mine, which is located near both the Cruzeiro and Pederneira mines. Domingo knew Keké and decided to offer him

***Figure 8*. Eustacio Neves, one of the partners from 1999 through 2006. José Menezes photo.**

***Figure 9*. Zé Menezes collecting in the Azul Bien Grande Pocket in 2004. José Menezes photo.**

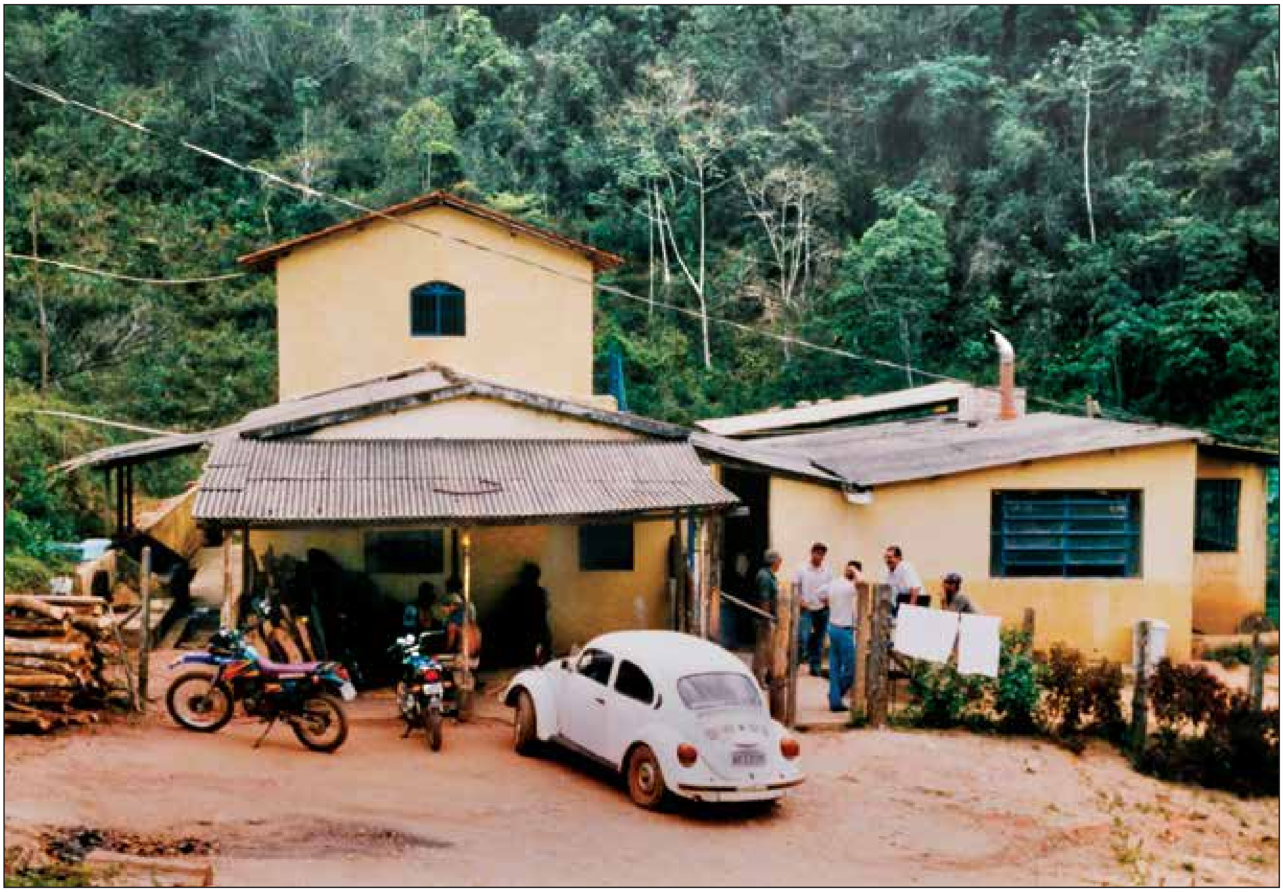


Figure 10. **The main house at the Pederneira mine in 2000, where Wilson Tomich visited during his search for the source of the Keke's Pocket tourmalines. Daniel Trinchillo photo.**

Figure 11. **Partner Wilson Tomich (*left*) and owner Alexandre Duarte de Oliveira Rocha (*right*) overlooking partner Saint-Clair Fonseca, Jr. aka Keké (*center*) evaluating gem rough from Thiago's Pocket.**

the lot. Keké, as luck would have it, was on the eve of leaving for the United States to attend the annual Tucson Gem and Mineral Show, and he almost decided to skip the meeting with Domingo; instead he waited to see the material, and soon was extremely glad he did. The crystals proved to be outrageously high in quality, with good gemminess, color and luster, and they are associated with the best pink lepidolite he had ever seen!

Keké quickly closed a deal for the specimens, then wrapped them up and packed them to take with him to Arizona. Keké was a good friend of another gem dealer, José Miranda da Costa Jr. (known simply as "Miranda"), and they were traveling to the U.S. together. So Keké shared with Miranda the news of his recent acquisition and showed him the crystals. Miranda, too, was immediately thunderstruck by the quality of the specimens and wanted to know the locality, but Domingo had not told Keké where they had been found; Domingo had said that he honestly did not know. And anyway, Keké had been more concerned with securing the specimens before taking off for the states than with learning the exact locality.

Keké was a gem dealer and cutter, and although the tourmaline crystals could certainly be cut, Keké decided (thank goodness) that they were probably worth more as specimens than as gem rough. He called Pierre Laville, a well-known French dealer who

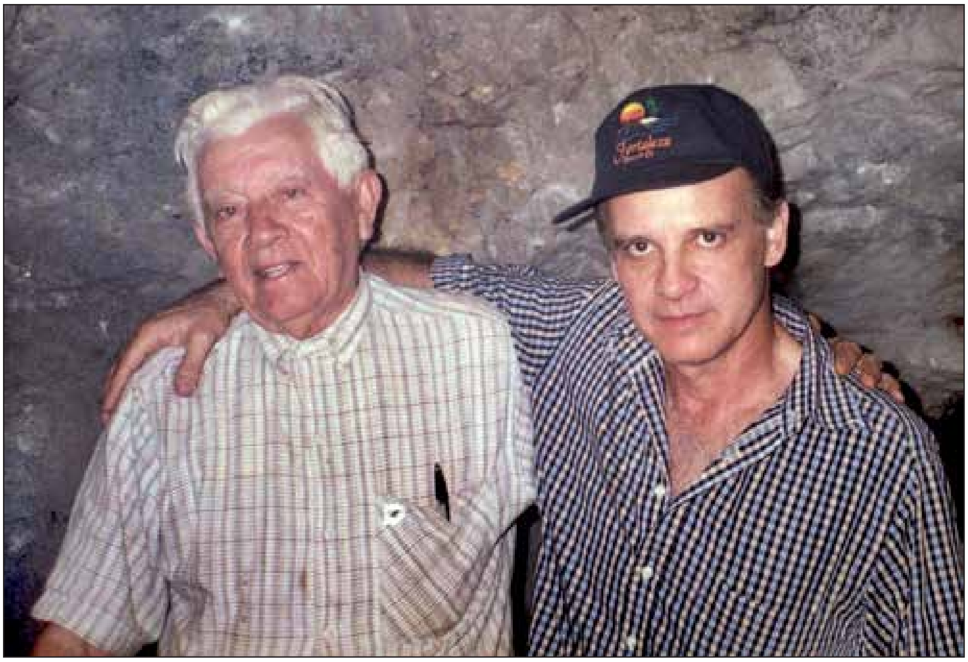


Figure 12. **José de Oliviera Rocha (nicknamed "Deca"), owner of the land where the Pederneira mine is located, and Zé Menezes underground at the Pederneira mine. José Menezes photo.**

Figure 13. **Claudino, the** ***fronteiro*** **(shift boss), showing tourmaline crystals just removed from the Azul Bien Grande Pocket in 2004. José Menezes photo.**

Figure 14. **Saint-Claire Fonseca, Jr. ("Keke") in front of an emptied pocket in the Pederneira mine, 2004. José Menezes photo.**

was living in Brazil and who had direct connections to Wayne Thompson, one of the most prominent high-end mineral dealers in the U.S. at that time. They made an appointment to meet at Sky Harbor Airport in Phoenix on the way from the east coast, and the specimens changed hands right in the airport. Pierre immediately sold the material to Wayne Thompson, who then dispersed it to the collecting community, even though the locality still had not been revealed. (A full description of the pockets and the specimens they produced follows in "The Pockets" section beginning on page 61.)

Miranda called his old friend Wilson Tomich back in Brazil and described to him what the material looked like, emphasizing how wonderful it was, and asking Tomich if he could track down the mine where they had been found. And so Tomich set out to find the source of the lovely new material. His tour of Brazilian mines and mining towns lasted two weeks, including the days during which the 2000 Tucson Show was taking place. First he called one of his old friends, Zé Menezes, who at the time was the owner and operator of the Santa Rosa mine, and asked if that mine had recently produced anything. Menezes reported that nothing had been found lately, but promised to start an investigation to see what he could learn. Nothing came of this investigation.

Finally Tomich found a lead. He located a Governador Valadares dealer named Lezito who had somehow acquired a small piece of what was clearly the same material. Lezito claimed that it was from the Pederneira mine! Immediately Tomich headed out to the mine, where he met Dada and began learning about the situation.

As Tomich listened, he learned of Eustacio's involvement, and since those two had some unfinished business between them, Tomich was able to leverage himself into the partnership, waiving some

***Figure 15*. Deep green tourmaline with hot-pink lepidolite crystals, 16 cm, from Keke's Pocket. Scott Rudolph collection; Jeff Scovil photo.**

***Figure 16*. An array of tourmaline crystals and large lepidolite crystals recovered from Keke's Pocket and laid out for sale in Brazil in early 2000, before being purchased and brought to the Tucson Show.**

old debts due to him in return for an interest in the mine. Then, because it was Miranda who had put Tomich on the scent in the first place, he gave Miranda half of the shares he acquired in the deal with Eustacio.

Given that none of the three men working the mine knew that "Keké's Pocket" had already been collected and marketed, Tomich knew that he needed to keep someone on-site to watch over his new interest. So he called up a trusted miner and *fronteiro* (a senior miner who directs work at the front working face in a mine) who had worked with him in the past, Claudino. On the phone he learned that Claudino was working then for Menezes at the Santa Rosa mine. So Tomich had a thought: he called Miranda and explained that they needed someone with their interests in mind at the mine every day, and that if he, Miranda, agreed, he was going to invite Menezes to be a partner together with the two of them. Tomich respected Menezes as a miner and confidant, and he knew that with Menezes he could get Claudino too. Miranda said that was fine as long as he could invite his friend Keké—the one who had introduced him to the material in the first place—as he knew that Keké could run a great cutting house and maximize the gem rough production. And so was born a very unlikely partnership of the five men: Tomich, Menezes, Keké, Miranda and Eustacio. Together they formed a company to work with Dada and Deca, and the "M. Pederneira Limited" partnership was born.

World War II Era

The Pederneira pegmatite mine was discovered in the 1940s by a farmer named Pacheco, who was walking the area after a huge storm and found an outcrop filled with muscovite. World War II was in full swing at the time, and the demand for muscovite was high. Pacheco knew that Americans were mining for muscovite nearby at the Cruzeiro mine, so he collected several barrels full of muscovite and hauled them by mule to the nearest town, São José de Safira, where he sold them to the Americans. Thus the Pederneira mine was born; its namesake is a small river that runs at the bottom of the mountain where the mine is located.

The Americans investigated the mine themselves to see if there was enough muscovite to make a larger operation worthwhile. There wasn't, so the mine was left to the locals. The war ended and Pacheco moved on.

***Figure 17*. A large sheet of mica, about 30 cm across, with a spessartine inclusion, from the Pederneira mine. Marco Lorenzoni photo.**

***Figure 18*. A pile of mica books from the Pederneira mine, like those sold by Pacheco to an American mining company in the 1940s.**

Figure 19. **Tourmaline with cleavelandite, 15 cm, recovered from Dilo's Tunnel during the first era of mining. Stephen Smale collection; Stuart Wilensky photo.**

First Era of Mining
(Dilo's Tunnel)

The mine sat dormant until the 1980s, when it came back to life—this time through the efforts of a local miner named Geraldo Neves. He worked the same tunnel that Pacheco had begun and extended it 30 meters into the mountainside. Unfortunately for Neves, he discovered nothing, and soon he gave up.

Neves was followed by another miner known as "Natinho," a notorious gambler who decided to try his hand at the mine and hit an *enormous* pocket of bicolored tourmaline and deep red rubellite after mining for just 2 meters! The landowner, Deca, who was partners with Natinho, invited Dilermando Rodrigues Melo, a local gem dealer in Governador Valadares, to come and evaluate the find.

***Figure 20*. Tourmaline with cleavelandite, 14 cm, recovered from Dilo's Tunnel during the first era of mining. Current owner unknown; Jeff Scovil photo.**

***Figure 21*. Partners Junior Tomich (left) and Keké (right) with mine foreman Adeclides at the portal of Dilo's Tunnel during the period in which it was being mucked out.**

Deca is considered the patriarch of his hometown of Santa Maria do Suaçui, and at over 90 years old he is totally charming, with a full head of white hair and a pearly white smile. He is proud of his good health at his age and especially of his teeth. More than once he has been known to bite clean through a chicken bone to show off the strength of those teeth.

Dilermando and his son Dilermando Rodrigues Filho (known simply as "Dilo," a name given to the tunnel as well) took Deca up on his invitation and, after seeing the material, immediately purchased the whole contents of the pocket Natinho had hit. Not wanting to leave the crystals unprotected at the mine, and with

***Figure 22*. Tourmaline crystals with white herderite (unrepaired), 11.5 cm, recovered from Dilo's Tunnel during the first era of mining. Andreas Guhr specimen, James Elliott photo.**

***Figure 23*. Tourmaline crystal on cleavelandite with lepidolite, 43 cm, recovered from Dilo's Tunnel during the first era of mining. Adalberto Giazotto collection and photo.**

no other packing supplies on hand, they turned to the jungle for help—wrapping everything in freshly cut banana leaves for protection. Dilo recalls grading and packing specimens for days, and ultimately filling up the cargo hold of three two-ton trucks! That's almost 6 tons of tourmaline, less a banana tree or two.

Thus began the first significant era in the history of the mine. Natinho spent his new-found fortune in a matter of weeks, mostly on alcohol and at the card tables. Dilo saw an opportunity, and he and his partner Julio Cipriano negotiated with Deca to lease the mine. They found literally tons of tourmaline, morganite, quartz and albite over the next decade. It was a long-term bonanza which Dilo remembers well. Never had he seen so much beautiful material produced from any one mine. Specimens found at this time came from the aptly named "Dilo's Tunnel." Sadly, of all the incredible specimens they produced very few were documented. Because the tourmaline was of such high gem quality, a huge portion of it was cut for the gem market. I have heard descriptions of specimens with tourmaline crystals over 2 feet long and 5 inches in diameter flaring off beautiful bladed albite crystals with grapefruit-size morganite crystals on the side. One can only dream about such specimens. And, whether true or strongly embellished, these stories, as told to me by the foreman who ran the mine at the time, the late "Adeclides," induced both goosebumps and chills when I tried to imagine not only what had been found, but what, horribly, had been destroyed!

As the story goes, by the early 1990s the frequency of the pockets began to wane and most of the tourmaline coming from the zone being mined was green—and the value of green tourmaline was low on the world market at that time. With disagreements over which direction to follow underground, and with mostly just green tourmaline being found, the duo of Dilo and Julio decided to close the mine. But they did not want anyone else mining there either, so

***Figure 24*. Tourmaline crystals (doubly terminated), 20 cm, recovered from Dilo's Tunnel during the first era of mining. Gerhard Wagner collection; James Elliott photo.**

***Figure 25.* Morganite crystal on cleavelandite with quartz, 25 cm, recovered from Dilo's Tunnel during the first era of mining. Rob Lavinsky (The Arkenstone) specimen; James Elliott photo.**

***Figure 26*. Tourmaline crystals with cleavelandite and lepidolite, recovered from Dilo's Tunnel during the first era of mining. Jeff Scovil photo.**

before they closed the tunnel in the early 1990s they back-blasted large tunnel sections in order to bury the mine, they supposed, forever. Thus they brought more than a decade of successful mining to a close and left Pederneira sleeping for nearly another decade before Dada woke her again.

Dada's Tunnel and the mining pursuits at Pederneira from 1999 to the present are the main topics of this article. But we have also recounted as much as could be learned about the earlier part of the mine's history, before it is forgotten. Documentation of what was produced in that earlier time is virtually nil; the oral accounts are like wonderful, semi-mythical tales of monstrous tourmaline crystals with associations beyond your wildest dreams. I have no doubt that these stories are rooted in facts, since many and varied sources tell similar tales. But exactly what was produced remains mostly unknown—no pocket descriptions or specimen names, no real timeline, and very little photographic documentation exist. I made several attempts to collect information about the finds and the sizes of the pockets, and to locate photos, but the finer details had long ago been forgotten, only general impressions remaining in the memories of those who had been involved. What I *was* able to find was a small number of fine specimens that I know for a fact came out during the first era of mining at the Pederneira mine, when Dilo and Julio were unearthing treasures. I share those here as a tribute to that first era and as a prelude to the descriptions, in far more detail, of the two subsequent eras.

Second Era of Mining
Dada's Tunnel (1999–2007)

A History of Pockets Found

The history of an era is, most importantly, the history of specific discoveries. The important pockets discovered during the second era are all described in the section called "The Pockets." Here we will discuss the other factors that have come into play, including the distinctive nature of Pederneira tourmaline, the techniques used for breaching and collecting a pocket, the conditions in which pockets are found, security measures employed, and the reconstruction process utilized to bring specimens back to their original glory.

Distinctive Features of Tourmaline

What is noteworthy about the Pederneira mine is that specimens from every pocket have their own distinctive and diagnostic features—characteristics of the crystals that are unique to that pocket. Although there have been a few very similar pockets, no two pockets are truly identical. For example, the "Afghan Pocket" contained pastel green tourmaline crystals with a colorless horizontal zone going through them at about 2 cm down from the terminations, but only on the pyramid-terminated (antilogous) crystals. The crystals with flat pedial (analogous) terminations in the same pocket all have a red core that extends to just 2 mm below the termination, where it is capped by a sea-green zone with brilliant luster. No other pocket from Pederneira (or any other mine, for that matter) has crystals with these features, and so when you see an example you can immediately know that it is from the Pederneira mine and specifically from the Afghan Pocket.

The highly varied combinations of colors and habits of beautiful matrix tourmalines have made Pederneira specimens prized by collectors around the world. Many collectors have suites of tourmalines just from the Pederneira mine, with examples from each of the important pockets. The combinations seem to be endless, and with every pocket discovered there is something new to surprise us! Pederneira truly shows us the rainbow of colors that tourmaline can display.

Pocket Sizes and Shapes

Pockets at Pederneira come in all shapes and in sizes ranging from as small as a tangerine to as big as a sixties-style Volkswagen bus. Obviously the latter are much more exciting to discover! But some of the most incredible pockets for quality have been those that are relatively small, from basketball to large beach ball-size. Small pockets can usually be collected in a day or two, but larger pockets can take a week or more to collect; on one occasion the process took nearly a month. One thing is for certain: the more slowly a pocket is collected, the better the results. This is a process that cannot be rushed.

Commonly, the pockets are found filled with water and begin to drain when they are breached. The flow of this water can be used to estimate pocket size, by the length of time it takes for all of the water to drain out.

Just because the drill bit jumps does not mean a pocket has been hit. It could simply be a fissure in the rock, or a large expansion seam, or a barren pocket . . . or it could be a huge pocket with thousands of beautifully colored tourmaline crystals growing in every direction. But we never know from that first leap of the drill, so every such occurrence has to be treated in the same way.

Pocket Conditions

Pockets in the Pederneira mine are encountered in a variety of physical states. They can be found totally intact and as pristine

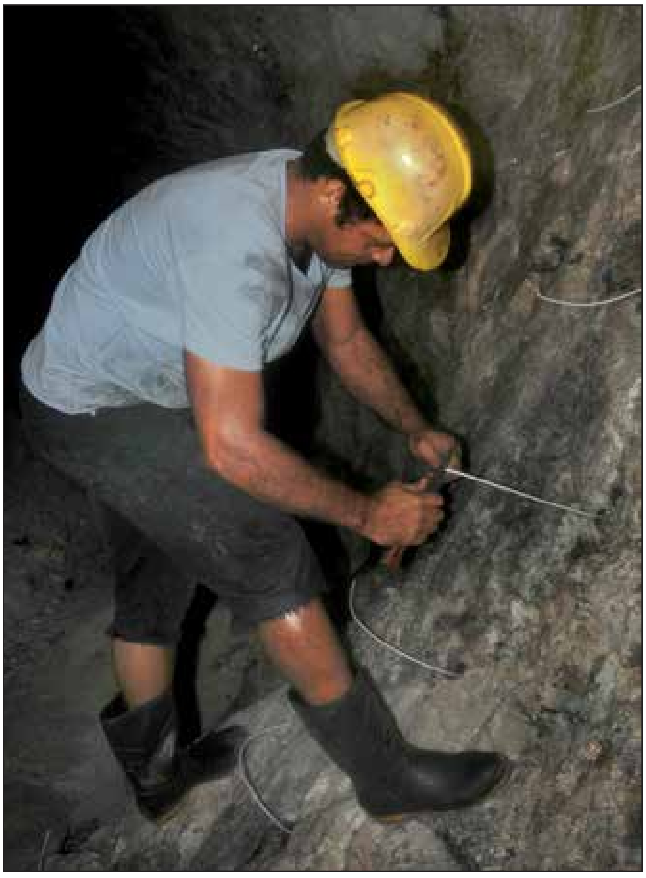


***Figure 27*. Trimming fuses for a round of dynamite. Marco Lorenzoni photo.**

Figure 28. **Tourmaline crystals with cleavelandite, 14 cm, from the Afghan Pocket. Fine Minerals International specimen; James Elliott photo.**

as they were when formed millions of years ago (like the famous Jonas pocket near Itatiaia), but this is exceedingly rare. Most of the pockets in the mineralization zone have deteriorated as a result of natural processes: tectonic shifts, intrusions by clay or water or sand, or simply the breakage of crystals because they have grown so long and so heavy that they cannot support their own weight and break spontaneously in the pocket. Crystals often break during the sometimes explosive decompression phase of pocket formation, and we find many crystals that have broken but healed on one side, or become doubly terminated, as crystal growth in the pocket continued. Pockets can be totally collapsed or totally decomposed. The most common pocket types are some combination of these various states: partially intact, partially decomposed, partially collapsed and partially filled with mud, for example. Obviously the variations in pocket conditions are numerous, and you never know what you are going to encounter when you begin to open a pocket.

Breaching Pockets

An important factor influencing specimen survival is the way in which miners reach these pockets. Some pockets are found when a blast cuts through part of it, leaving the pocket open on the working face and some of the contents blown all over the floor! Think of tourmaline, albite, and lepidolite strewn all over like shrapnel from a grenade. Even worse, other pockets are inadvertently blasted to bits by dynamite rounds which happened to go off too near them, leaving nothing but traces of broken crystals in the rubble.

Sometimes, when driving tunnels, the miners completely miss pockets lurking just a few centimeters behind the wall or the floor

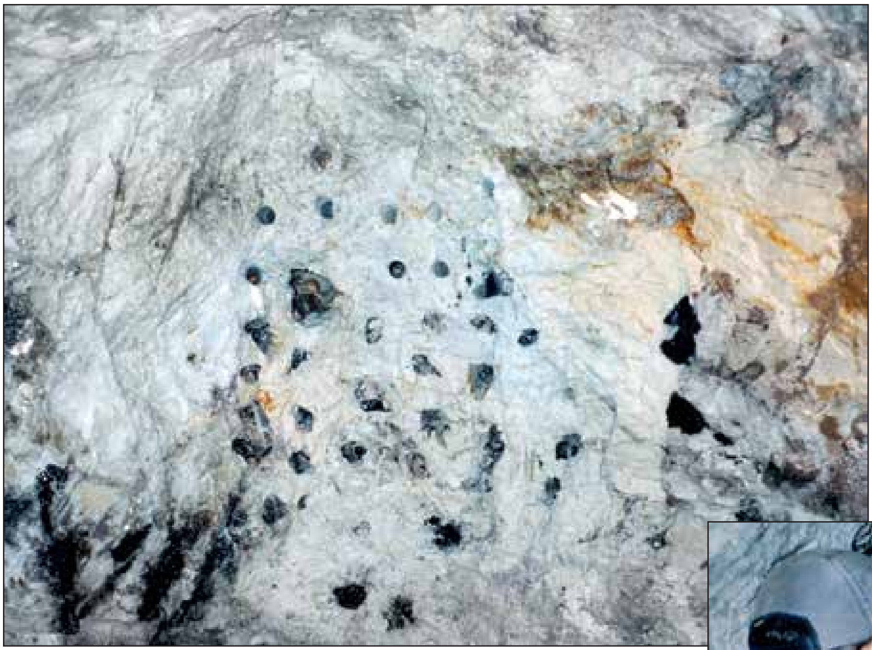


***Figure 29*. Working face near a tourmaline pocket, drilled into "Swiss cheese" and soon to be broken up using the hydraulic rock splitter.**

***Figure 30*. Miners using the pneumatic rock splitter to carefully break apart the pegmatite without causing shock waves that could damage crystals inside.**

***Figure 31*. Rubellite gemstones cut from Pederneira tourmaline crystals. Marco Lorenzoni photo.**

or the ceiling. Imagine what the contents of a missed pocket like this must suffer when mining passes close to it while a tunnel is being driven with round after round of dynamite blasts! The closer those pockets are to the tunnel walls, the more they are shaken up by the blasts, and obviously such a pocket, when it is discovered (not all are), will be much more challenging to collect than if it had been discovered before the blasting.

We will never be able to entirely prevent these scenarios from occurring, but minimizing their frequency is incredibly important. Limiting the impact of the mining process on the pockets and collecting them in a careful way is vital for preserving both specimens and gem rough. We try to discover pockets through the use of exploratory mining techniques that allow us to preserve the pockets in a natural, undisturbed state.

As soon as a nearby pocket is detected, all blasting stops, and drillers attack the face, making Swiss cheese out of the rock, partly to define the pocket shape, size and location and partly to make room for the hydraulic rock splitter to be utilized. Before we make use of the splitter we insert a special endoscope into the drill holes to have a peek inside. The endoscope we use can go in almost 5 meters and has a camera with a pivoting head and light on its end. On occasion the scope has proven useful, but in most cases the images are not revealing enough to let us understand what is going on in the pocket.

Once the drill holes are completed and scoped, we use the hydraulic splitter to crack all the rocks into pieces and slowly, block by block and all by hand, the miners work at clearing the rock away until they reach the pocket. This can easily take days, in some cases, and the moment of truth is not always a happy one. Many times we mine carefully up to pockets that prove to be totally empty or unmineralized. But about one in every five of those pockets turns out to be filled with beautiful tourmaline specimens that make it all worthwhile.

Collecting Techniques

In the early days of mining in Dada's Tunnel (1999–2002) the miners had not yet developed specimen-collecting skills, or even an understanding of why it is so important to collect specimens

Figure 32. **(*above*) Tourmaline gemstones cut from Pederneira mine rough, clockwise from top-left: 20.52 carats (Blue Gem Pocket), 17.69 carats (Blue Gem Pocket), 17.48 carats (Blue-Green Pocket), 11.33 carats (Blue-Green Pocket), 11.29 carats (Blue-Green Pocket), and 12.75 carats (Blue Gem Pocket). Fine Minerals International specimens; James Elliott photos.**

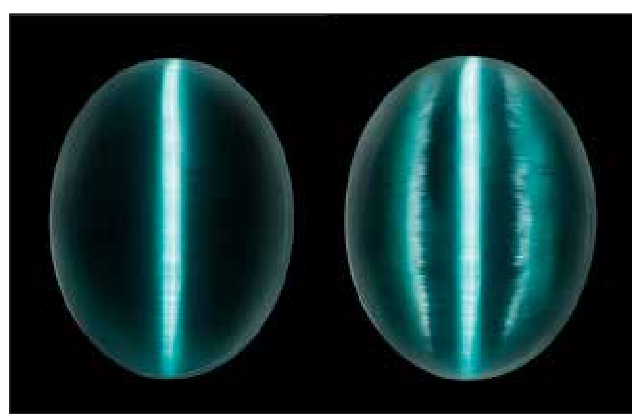


***Figure 33*. (*right*) Cat's-eye cabochon of tourmaline (two views), 38.6 carats, from the Proud Pocket. Fine Minerals International; James Elliott photo.**

carefully. It took time to train everyone involved, giving them a new point of view. All of the partners and miners (except Wilson Tomich) came from lapidary and gem backgrounds, so the first challenge was to convince them all that their mine was special. Not only does the tourmaline from Pederneira have wonderful attributes for being transformed into gemstones but, just as importantly, it can produce some of the world's finest mineral specimens. This duality is something that few miners in the world have understood, let alone embraced. We see mines that produce quantity and high quality of gem rough but almost no specimens—like the Cruzeiro mine and the Mutuca mine, also in Brazil. And we all know wonderful specimens from the Pala district in California. But few places produce simultaneously the finest in cutting rough and in specimens. So my first job in mid-2000, when I began working with the team at Pederneira, was to change the mentality of the miners and the partners.

Convincing the partners was not a very difficult task at all. Most of them immediately recognized the beauty of the specimens the mine was producing. And when I explained how the selling prices those specimens could bring were so much higher than what they would bring if sold as cutting rough, the partners were easily persuaded. Nevertheless, habits are hard to break, and they did not immediately implement the mining techniques necessary to take maximum advantage of the specimen potential.

The miners required a lot more convincing and educating before they were finally agreeable to collecting and preserving crystal specimens. Bringing everyone up to the same level of consciousness was a challenge. They needed to really believe that carefully

Figure 34. **Demonstrating the use of the diamond chain saw for removing crystal pockets (2001).**

Figure 35. **Cleaning out the 18% Pocket.**

Figure 36. **Zé Menezes pointing out a pocket in Dilo's Tunnel. Andrea Dini photo.**

Figure 37. **Rinsing out a tourmaline pocket with water. Andrea Dini photo.**

collected specimens can be worth more than cutting rough, and that cutting rough extracted with the careful techniques designed to protect specimens would benefit as well, and would cut to yield finer quality gems in larger sizes with more total carats produced.

Early on in 2000 and 2001 I was lucky enough to have been present at the mine when a pocket was collected. It was a life-changing experience; never before had I been on hand at the exact moment when crystallized specimens were being dug from a pocket, and it was as incredibly exciting as it was horrifying. The miners at the working face were looking for tourmaline, and getting it out in one piece was not really a consideration. Just knowing what they destroyed is heartbreaking, but to have seen it happen is even worse. The collecting practices used on many of the very first pockets were barbaric. Shovels were thrust directly into open pockets, breaking and chipping everything in their path. The material was scooped up and poured into bags to be carted to a sorting room, where it was again dumped out onto a table and sorted in search of remaining crystal sections and broken tourmaline pieces. It is a miracle, but

Figure 38. **Removing matrix pieces from the Grandon Pocket using the diamond chain saw.**

Figure 39. **A tourmaline specimen freshly cut from the Cranberry Blue Pocket and awaiting trimming.**

despite the shovels, pick-axes and heavy pry bars, a few incredible specimens found in the early days did manage to survive.

Thankfully, Zé Menezes, the partner who was the most active at the mine, took charge and helped develop practices and methods of collecting at Pederneira that were specifically designed not only to locate pockets before we blew them into bits but also to collect them properly once they were found. Instead of drilling only a meter into the face and loading the holes with dynamite, we began drilling 3 meters, and in some instances 5 meters. When a drill bit breaks into a pocket the drill leaps forward, and the miners know there is a chance that a pocket has been hit. It could be just an empty cavity or a crystal-lined vug, but all such instances are treated equally and the slow process of drilling and splitting to open the pocket begins.

The crude early tools once used to collect pockets have been replaced today by chopsticks and diamond chain saws. Our new techniques are slow, deliberate, and similar to those you might see in use at a fossil excavation of an incredibly important dinosaur. As mentioned, when the pockets are first found they are often collapsed. Most people, when shown such a pocket, would not even realize what it is. But the newfound pocket is photographed, studied, and rinsed with water ever so gently, so as not to wash away a single fragment that could be useful in the reconstruction process. Slowly and meticulously, piece by piece, the pocket contents are uncovered and collected, packed safely in exactly the same order as found. Crystals are no longer scooped, but are carefully gathered one by one and laid in boxes with soft cushioning ready to receive them.

Figure 40. **Tourmaline specimens from the Cranberry Blue Pocket on shelves in the Pederneira house**

Figure 41. **A pale smoky quartz crystal freshly removed from a pocket in Dilo's Tunnel. Andrea Dini photo.**

Chopsticks are used to carefully dig out small broken pieces or dislodge a fallen crystal from a group of other crystals. It is like collecting the pieces of a gigantic jigsaw puzzle and trying to get every single piece out of the pocket safely and into a controlled environment to begin the repair and reconstruction process.

The diamond chain saw has been a game-changer in modern professional specimen collecting, and we take full advantage of it whenever we can. We use it to cut out large specimens where necessary and to remove the pocket walls. The entire pocket lining has to be removed and preserved to see what can be reassembled and what cannot. The process is slow and tedious, and sometimes, even with all the precautions in the world, specimens are still damaged.

Specimen Reassembly

The next step is to reassemble the pockets in order to understand what specimens we actually have. At the time the pockets are being collected, very little is really known about what level of specimens we have found. It is easy to determine certain factors: crystal size, color, clarity, luster, transparency, habit and associations are all things that are immediately apparent. But the locations of "footprints" where crystals have broken off from the matrix, and of contacts where they were once touching each other, are usually unknown at the time of extraction. So we then enter into the next phase of "mining," namely the reconstruction and reassembly process.

A pocket's value and importance cannot be accurately known until the pocket has been reassembled into its original configuration. Every tourmaline crystal recovered has a unique diameter, shape and broken surface that will only match a particular footprint where it has broken off from the matrix. So when crystals are reunited with the location where they once grew, without any missing parts

***Figure 42*. Tourmaline crystals soon to be reunited with their proper places on matrix.**

***Figure 43*. Re-attaching a tourmaline crystal cluster to its proper place on matrix.**

or gaps, then we say they "lock-fit" into place and can be repaired very easily. A "clean break" or a "lock-fit" are industry terms that most collectors understand; they denote the simplest situations to deal with for purposes of repair and reconstruction. Sadly, it is not always so easy: some crystals are broken into two, three, four, five or six pieces . . . or more. The possible puzzle combinations seem endless. Completely reassembling a pocket just to understand what we have takes at least a month and sometimes six months; a particularly large pocket can easily require a year or more.

The contents of each pocket are laid out in its own room in the Pederneira house and are never mixed with contents from another pocket. The pocket is organized and sorted in a number of ways to help expedite the reassembly process. Crystals are sorted by a number of characteristics: length, diameter, type of termination (analogous or antilogous), color, rehealing, double terminations, whether or not some matrix is attached, whether there are areas of contact with other crystals, and so on.

Matrix blocks are washed with water and cleaned with a mild acid to remove iron staining, pocket clay and mud. After they are cleaned the real work begins—that of connecting the crystal pieces to each other and back onto the correct matrix sites. Every connection of a crystal to its former place of origin creates a specimen we were previously unaware of. This discovery process can be just as exciting and fulfilling as actual mining underground. Imagine having a beautifully crystallized specimen of albite with rosettes of purple lepidolite and four 7-cm gem tourmaline crystals flaring off of it. However, in the center there is a depression 3 cm across where another, bigger crystal which is still missing once grew. And then you find that crystal. The experience of exactly lock-fitting a 20-cm gem crystal back into its place is indescribable!

As integral as Zé Menezes and his son Thiago have been to the mining process at Pederneira, Wilson Tomich Junior (aka Junior) has been integral to the "mining process" in the reconstruction rooms. Junior took over as the representative of his father's shares in the partnership around 2005. Since then he acts as the Chief Operating Officer and Chief Financial Officer of the company and is the head lab technician responsible for assembling all the tourmaline speci-

Figure 44. **The Pederneira House in Governador Valadares, where tourmaline pockets are reassembled and the company offices are located.**

Figure 45. **Wilson Tomich, Jr. fitting the last crystal back onto the matrix of a fine specimen in the Pederneira House in Governador Valadares.**

mens. He runs the Pederneira house on a daily basis and without his expertise in reassembling the specimens, many incredible pieces might never have made it into collector's hands.

Final Preparation

And so this process of mining followed by reconstruction happens over and over for every pocket discovered. The completed pockets are evaluated, then moved on to the next phase. Once we reach the point where we can assemble the pocket no further, we document all the pieces and then dissemble them entirely. The last step is to have the final cleaning, trimming, repair and restoration done in one of the few professional mineral specimen labs in the world.

Security

Security is heightened during pocket collection. Normally we have two armed guards patrolling the property and watching for potential robberies. For the most part the mine is safe, but still it is in a remote area, beyond the reach of law enforcement. We have to be wary of planned attacks. One such attack took place in 2008, before we had upgraded the security of the mine camp. (More later about the "Gunfight at Pederneira," as we call it.)

As we collect any given pocket we concurrently move the extracted material to the Pederneira house in Governador Valadares, owned by the partnership. As mentioned, we charter a helicopter to transport the precious cargo back to where we can safely begin the evaluation and reconstruction process. The ride is no more than 30 minutes each way, and we can usually move an entire pocket in a few trips. Larger pockets are transported over a course of days and stored until the whole pocket is in one location.

As mentioned, "The Pockets" section beginning on page 61 details all of the major pockets found in Dada's tunnel. By 2007 the miners had determined that there was no more tourmaline to be found there, and it was closed in early 2008.

Figure 46. **"The crossroads" underground in Dilo's Tunnel, where all levels diverge, the lowest level extending down to a depth of 800 meters. The track on the right is horizontal and is the highest of the four levels in Dilo's tunnel; the left track slopes downward to the lower levels. All of these workings needed to be mucked out, debris removed, electricity installed, and the walls power-washed so that we could see the rock and figure out what we were dealing with. Bryan Swoboda photo.**

Third Era of Mining
Reopening Dilo's Tunnel

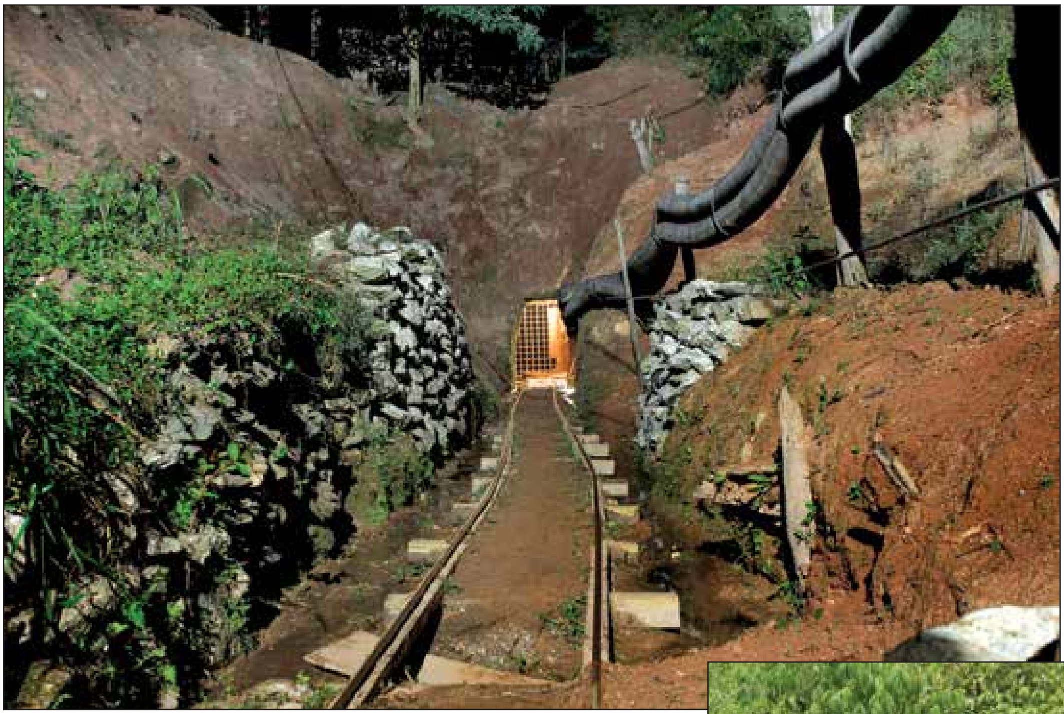


Figure 47. **The portal to Dilo's Tunnel six years after renovation began for the third era of mining at Pederneira. Fine Minerals International photo.**

Figure 48. **The overgrown Dilo's Tunnel portal as it appeared in 2005.**

The third era of mining actually overlaps the end of the second era that was going on in Dada's Tunnel in 2005. While mining was in full gear in the upper tunnel I had the idea that there was a potentially untapped resource in the original tunnel below, which had been lying dormant since Dilermando and Julio abandoned it in the early 1990s.

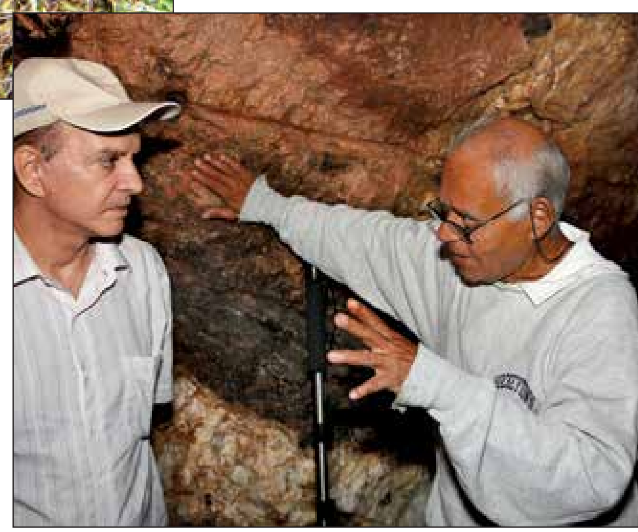
Where the old tunnel entrance had been there was nothing but an overgrown hillside with what seemed like a small nook in it, and as you approached you could see what looked like a mudslide over an opening strewn with logs, rocks and vegetation.

The thought occurred to me that if Dilermando had successfully mined the lower (Dilo's) tunnel for almost a decade and found pocket after pocket, he most likely missed some, certainly a few, perhaps dozens! I figured that he could not have been mining with any more prescience than the fellows currently working in the upper (Dada's) tunnel. I had seen things get missed in Dada's Tunnel and later found by accident. I had convinced myself that Dilo's Tunnel had a whole other life ahead of it. Now I just needed to convince everyone else.

First I spoke with Zé Menezes and told him my idea. Zé is a mine operator, a real treasure hunter, and just the thought of finding a productive pocket sets his blood racing. He agreed that it might be a good idea to begin the project. In the upper tunnel I was a partner in the productions, but not in the mine itself. In the lower tunnel I was looking at becoming a partner on the ground level. So I proposed a deal to the partners in which we (Marcus Budil and I were partners through the whole of the second era) would pay all the expenses in return for a 50% stake in whatever was produced

***Figure 49*. Collapsed earth near the Dilo's Tunnel portal in 2005. Renovation of the mine took nearly five years.**

***Figure 50*. Adeclides, who supervised mining in Dilo's Tunnel during its first era of mining, describes to Zé Menezes what was found there in the "old days."**



from the lower tunnel. We would capitalize on the existing support structure of the upper workings and just add supplementary labor to begin breathing new life into Dilo's Tunnel.

By May of 2005 we had reached an agreement, and at that time we made our first investment to begin the mucking-out process. Originally we suspected that it might take the better part of a year to refurbish the tunnel, but it turned out to require nearly two and a half years of cleaning and infrastructure work—and at nearly three times the originally estimated expense.

Zé located Adeclides, who had been the mine foreman for Dilo's Tunnel back in the 1980s and 1990s, and asked him to join us and run the project. Adeclides agreed, and within three months he was living at the mine full-time. During the first few years I watched money just pour into the ground. Everything needed to be updated or reinforced, and most of the workings had to be cleaned out. The back-blasting that Dilermando and Julio were said to have done to prevent others from mining there proved not to be as bad as we had feared, though cleaning out the rubble was still a difficult task.

Once we had begun in the lower tunnel there was no looking back, and before we knew it we had so much money invested that we *had* to find tourmaline. By mid-2007 the miners in the upper tunnel had run out of worthy targets to mine, and the partners could not justify the expense of continued mining. By 2008 all of the infrastructure in the upper tunnel itself and the mine camp on the upper level had been removed—including all of the ventilators, compressors, drills, hand tools and electrical wiring. That part of the mine was closed for good.

Now all the focus was on the lower tunnel. Underground, the tunnel slopes downward into the mine at about a 35-degree pitch, branching off at four different levels. All of these workings needed to be mucked out, debris removed, electricity installed, and the walls power-washed so that we could see the rock and figure out what we were dealing with.

Gunfight at Pederneira

As if there weren't enough difficulties already, in early 2008 there was actually a gunfight at the mine. Up to that time, the Pederneira mine had been guarded by just a chain link fence and two guards with antique revolvers. Just before the incident, Zé Menezes had been robbed at another tourmaline mine, the Mutuca mine (near the Santa Rosa mine), which he owned. The Mutuca mine was producing almost exclusively cutting rough and was very stingy in giving up specimens of any consequence. Menezes had been successfully mining in Mutuca for about two years, and word of his success had spread across the countryside. A team of robbers who lived near the Pederneira mine heard about his good fortune and decided to rob the Mutuca mine at gunpoint; Menezes was almost killed in the fray. This was shocking news for all of us. The robbers escaped with over $250,000 in gem rough. In a frenzy and full of bravado after their successful raid on Mutuca, the same group decided to raid the Pederneira mine next. Within weeks of the robbery at Mutuca the guards at the Pederneira mine awakened one morning to discover a large hole dug near the portal of Dada's Tunnel, allowing access under the gate. They were unsure whether those who had dug the hole were still in the tunnel or had left, but obviously something had been going on. So, assuming that the intruders were still inside, the guards went down the hillside near the house to a safe area and planned an ambush. At around 1 a.m. people began to emerge from the tunnel. They had been mining, trying to collect some tourmaline. After a few shouts from both groups, bullets began flying up and down the mountain. Fortunately no one was injured and the intruders got away with nothing to show for their work. It was a rude awakening after nearly ten years of peacefully (and obliviously) going about our business. Luckily, we had been storing no specimens or gem rough on site at the time.

Figure 51. **Security at the mine includes a guard tower with armed guard, barbed wire, metal gate and guard dog paddock. Andrea Dini photo.**

Figure 52. **Stone guard tower on the hilltop overlooking the camp. Bryan Swoboda photo.**

These events led us to re-evaluate our security system and the way in which we handled ourselves during everyday operations at the mine, on the way to and from the mine, and in Governador Valadares. An initiative to increase security was undertaken, and we stopped mining completely until we had updated all aspects of our security. A watchtower was installed at the top of the hill, allowing armed guards to have a full bird's-eye view of the property, and another watchtower was built in the sleeping quarters, providing a second vantage point if a raid should take place. Ultimately these measures cost us over $100,000 and took almost six months to complete. Since that time we have had armed security continually on site and ready to meet any threat. Where there is treasure there is risk, but since security has been enhanced the mine has been peaceful and we have not met with any unauthorized "miners."

Bureaucratic Difficulties

In December 2008 the mine met with another obstacle. Just after all the improvements had been made and security established, the mine was closed by the government because the owners had let certain licenses lapse and certain inspections had not been conducted. The governing agency for mining (the Departamento Nacional de Produção Mineral, or DNPM) had been closing hundreds of mines, large and small, all across Brazil. This is one reason why very few new minerals of any kind have been available from Brazil since 2009. The DNPM and the Brazilian environmental protection agency (the Fundação Estadual do Meio Ambiente, or FEAM) inspected all operating mines and insisted that mining licenses be up to date and environmental restrictions be more strictly enforced. Dada's tunnel had already been exhausted and closed by then, and now the lower tunnel was being shut down by the mining regulatory agencies. From December 2008 through February 2010 we worked to recertify the mine with these agencies so that we could resume work in Dilo's Tunnel. Approval from both agencies came at last on February 1, 2010, during the Tucson Show. The majority of the Pederneira partners attend the show, and a celebratory dinner was held to toast the kickoff of our next mining campaign.

By this time the upper (Dada's) tunnel had been closed for nearly two years, and the lower (Dilo's) tunnel had been fully refurbished and mining was ready to resume. Target areas had been identified by our team (consisting of the miners and Zé Menezes) and a lot of expense had been incurred.

Mining began shortly after the Tucson Show, and nothing was found. We mined out target after target and by late 2010 we still

Figure 53. **Federico Pezzotta studying the pegmatite structure. Andrea Dini photo.**

Figure 54. **Zé Menezes, Marco Lorenzoni and Ju in front of a small pocket which unfortunately contained no tourmalines. Andrea Dini photo.**

had not found any tourmalines. Morale was low and every month the investment grew larger. We considered walking away from the mine and closing it altogether.

Outside Help Arrives

At this point I decided that something needed to change. I could not comprehend how a mine that had produced so much beautiful material could be so totally depleted. My feeling was that we were missing something: I could not resign myself to the notion that Pederenira had produced its last tourmaline pocket.

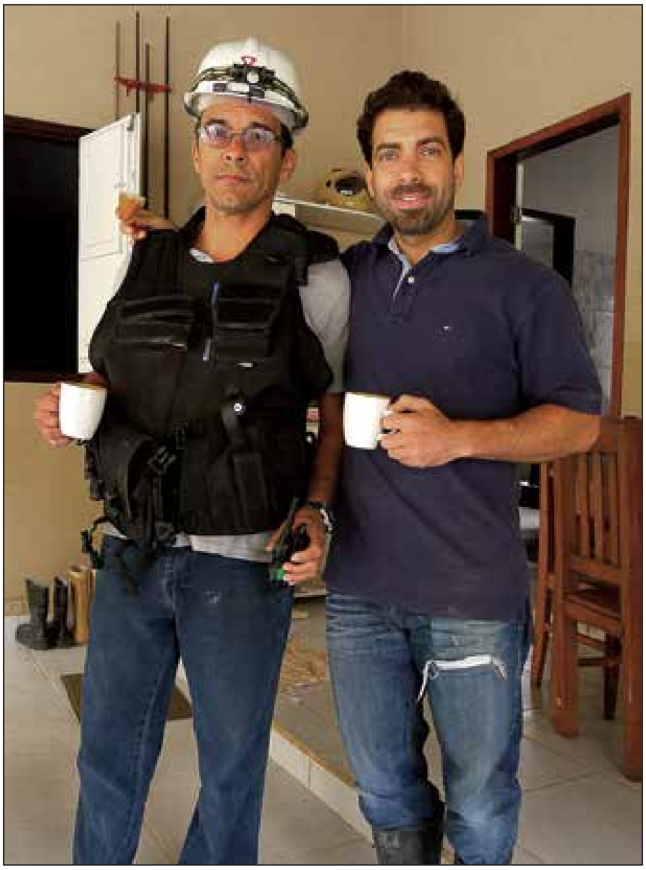
After being around the Pederneira mine for five years I had learned a lot about mining from a hands-on point of view. And it seemed apparent to me that no one on our team was really sure which targets were best, what the best direction in which to mine was, and how best to locate pockets. This suspicion was only beginning to dawn on me in 2005, but by 2011 it had finally become clear to me that there was no operating rationale behind the work that had been done in the upper tunnel. And I was the low man on the totem pole. Several of the miners had been doing this all of their working lives, and José Menezes, Wilson Tomich, Keké Fonseca and Eustacio all had been mining for decades before I arrived on the scene. But after my first five years I understood that all the good instincts in the world did not mean you could find tourmaline, and that often when you thought the vein was going to zig it zagged instead.

I decided that we needed the help of a geologist with an intimate understanding of the structure of pegmatites. And I knew just the

***Figure 55*. Federico Pezzotta, Zé Menezes and Marco Lorenzoni.**

***Figure 56.* (*below right*) The author with Marcelo Viera Compos (left), a cartographer who mapped the various underground workings at the Pederneira mine.**

***Figure 57*. (*below*) A meeting underground with the author, Federico Pezzotta, Andrea Dini, and miners Junio, Thiago and Elci. Chris Vaughn photo.**



one: Dr. Federico Pezzotta (who later became one of my co-authors in this article). Federico and I had become friends through our visits at shows and through the introductions of mutual friends. I knew him to be a very intelligent and articulate man whose opinions I trusted, since his understanding of the geology of pegmatites far exceeded my own. He was famed for his work on pegmatites in Madagascar, he had successfully mined for tourmaline specimens on the Island of Elba, and he had more field experience in pegmatite mining than any other scientist I knew.

I proposed to have him come to Brazil, visit the mine, and give us any insights he could into what we were doing wrong or what we could do better. He happily accepted, and in May of 2010 we made our first trip together to the mine. Along with Federico came his longtime friend and colleague, Marco Lorenzoni. Marco was there to help navigate the tunnels and do documentary photography. He is a seasoned and gifted field collector; few others I know can compete with him or keep up to his pace, but Federico is one who can. Of course, apart from coming to do an evaluation, the two gentlemen

***Figure 58*. An exposure of breccia fragments of paragneiss suspended in medium-grained pegmatite in the Domingo Venancio Tunnel at the Pederneira mine. Andrea Dini photo.**

***Figure 59*. On the couch, the author (blue shirt), Federico Pezzotta to his right and Junio to his left, discussing the mine plan with Marcelo Viera Campos (at the computer). Chris Vaughn (in cap). Andrea Dini photo.**

were bursting with excitement to visit the famed Pederneira mine. We do not make the mine accessible to many visitors, and even owners cannot show up unannounced with guests, so Federico and Marco were delighted to have this opportunity.

Happily, there were some signs of hope in early 2011. The miners had encountered four new pockets by the time we arrived, and it was a great boost to everyone's morale to see proof that there was more to find at the mine. Two of the pockets had low economic value; the other two were more important but still not valuable enough to offset all the costs that had been incurred. Nevertheless it was nice to have at least some production rather than none.

Federico and Marco dived into every nook and cranny of the mine. After a fun week and plenty of hours underground studying the visible geology in both Dada's Tunnel and Dilo's Tunnel, Federico arrived at a prognosis that was not very encouraging. He felt that there was little potential left in the upper tunnel, where he identified only one remaining target area. Other than that possibility, he thought, the upper tunnel was probably never going to operate productively again.

In the lower tunnel the scenario was similar: Federico was able to identify few virgin target areas to investigate, and felt that the only real potential left was to go back and rob the pillars as well as to work some of the lateral areas that might not have been fully exploited.

Needless to say, we all felt a little defeated, especially me, as I had been so sure that there was something major yet to come. At least, with Pezzotta's guidance, we were able to direct our efforts to better targets in Dilo's tunnel, and the idea of reopening the upper tunnel was food for thought.

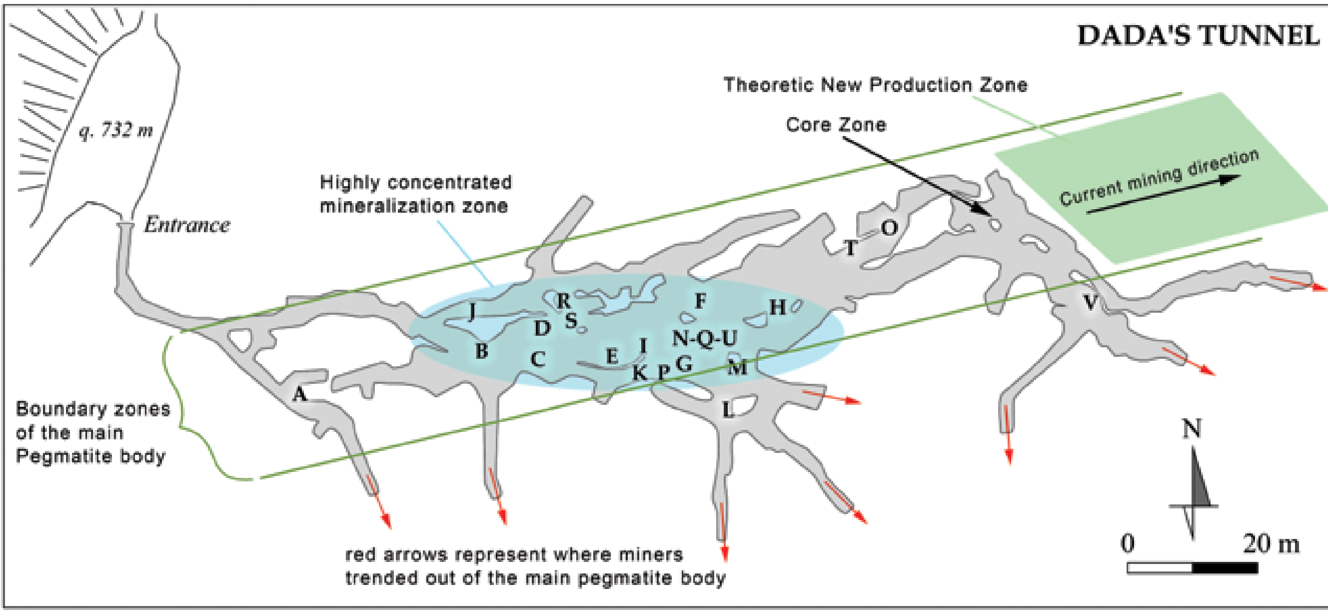


Figure 60. **Plan view of Dada's Tunnel showing current interpretation, with the locations of various tourmaline pockets indicated. (See pocket key for Figure 61.)**

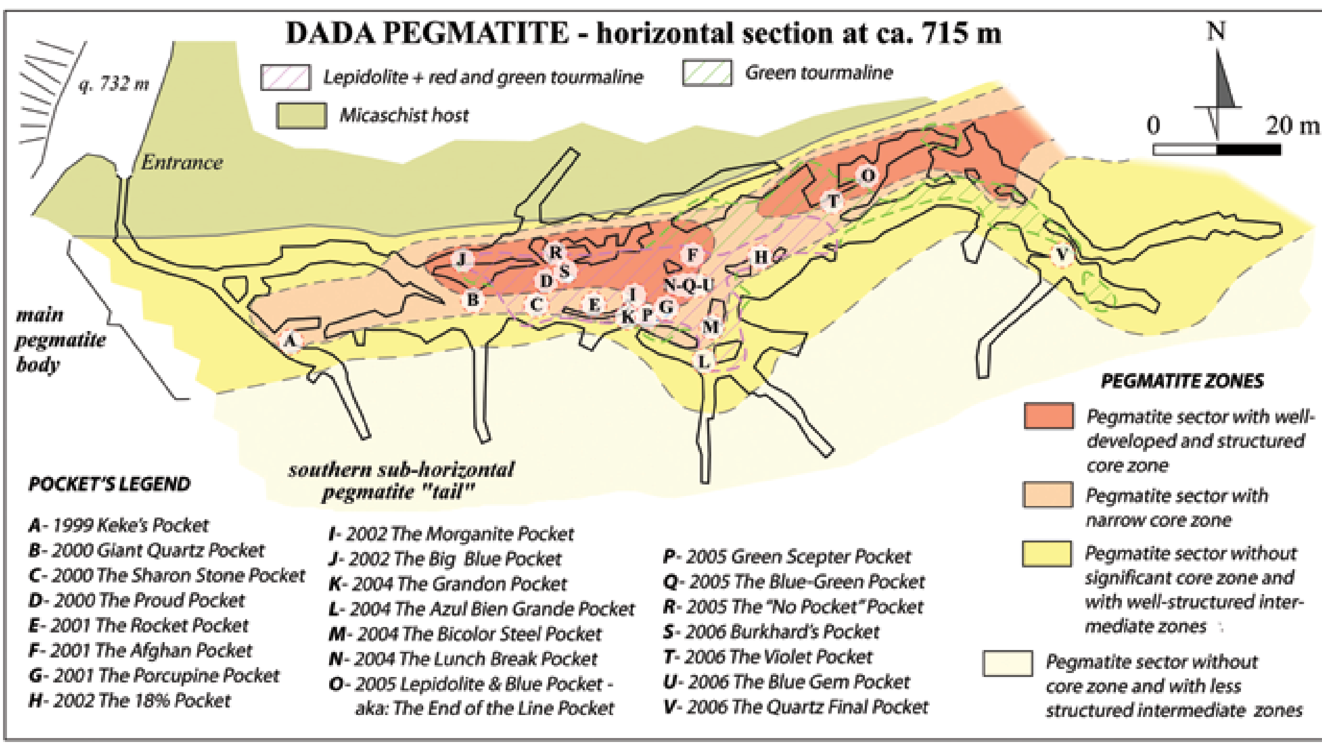


Figure 61. **Geological interpretation of the Dada pegmatite, with pocket locations indicated.**

So we continued mining the target areas we had pinpointed, hoping that something would pay off. By the beginning of 2012 it had been months since a pocket had been found, and morale was waning. By this time Dr. Pezzotta and I had become close friends and were collaborating on many projects across the globe, but Pederneira remained a constant topic of discussion. He had made a second visit to the mine in 2011, and we discussed different theories about the structure and genesis of the pegmatite. Pezzotta's ideas were evolving, and on his third visit he invited another friend and colleague, geologist Dr. Andrea Dini (who later joined us as coauthor), to come to the mine, look at the pegmatite and help theorize about the structure and the potential for more pockets. Pezzotta has great respect for Andrea's competence as a geologist, so I was excited to have both of them collaborating on the project.

Back in Italy, Pezzotta shared his observations and notes on the mine with Andrea. Meanwhile we stopped working the mine and cleaned all the tunnel walls in order to expose the rock in advance of the next visit by the two geologists. We also hired a local cartographer and mine engineer, Marcello Vieira Campos, who normally works full-time at the Cruzeiro mine, to map all of the mine workings in detail. It took him about four months of plotting, measuring and mapping coordinates, but in the end we had a perfect

***Figure 62*. The core drill being set up for the first test. Alexis Talbot photo.**

***Figure 63*. The core drill is set up for a test as Daniel explains the procedure to 90-year-old landowner José Oliveira Rocha (or "Deca" as he is known by all), who owns the mining rights to the Pederneira mine. Alexis Talbot photo.**

***Figure 64*. Drill cores carefully arranged in order and awaiting interpretation by the geologists.**

representation of the workings associated with Dada's Tunnel, Dilo's Tunnel and the two other neighboring workings at the mine. Dada's and Dilo's tunnels are the ones that had been productive, but there were two other major tunnels that had long been closed and that never had produced any important tourmaline discoveries: Cabo's Tunnel and Paulo's Tunnel.

By the next time the two geologists arrived at Pederneira in early 2013 they had the benefit of a comprehensive map of all the tunnels, with washed walls exposing the rock so that they could make direct observations. And with the clean-out and preparation of the other,

Figure 65. **Federico Pezzotta discussing the pegmatite structure with Daniel and Marcelo. Andrea Dini photo.**

previously closed tunnels, they could analyze the pegmatite in a much more comprehensive way than had previously been possible. All of these preparations had consumed much of 2012, but luckily we hit another pocket in Dilo's tunnel during that time. It was named Thiago's Pocket after Zé's son, who had assumed the main role of managing the operations at the mine and who personally collected the pocket together with Junior Tomich. It was a wonderful pocket and finally helped put a decent dent into the constant expenses the mine was incurring.

The Miners' Mistake Revealed

After the Tucson show in 2013 we made a trip to the mine to do another evaluation. Even before that visit, Federico and Andrea had begun to change their thoughts about the formation and the structure of the pegmatite—especially in Dada's Tunnel where they had the most detailed documentation and easily visible geology. Once they reached the mine and began studying the geology with all the new information and with infinitely better conditions for making observations, their evaluation changed completely.

It was becoming apparent that the miners, in following the mineralization zone in Dada's Tunnel as best they could by the successive discovery of pockets, had unknowingly been drawn outside the productive area of the main vertical pegmatite body and into a barren lateral extension of the pegmatite. This is evident from studying the maps and from plotting the visible rock as well as the location of each pocket intersected by the tunnel (see Fig. 61). Most of this analysis was done in Dada's Tunnel, where we had the most detailed knowledge of pocket locations. Using the maps and the access to the other tunnels, the geologists were able to create a complete model of the overall structure of the pegmatite.

Why did the miners fail to realize that they had gone off-track? As they had been following a trend dipping off-track into the lateral pegmatite, the appearance of the main body of the pegmatite changed in the critical area that theoretically represents its continuation. What had looked like lovely, finely crystallized pegmatite with lepidolite, cleavelandite and tourmaline at every turn had changed, in that area, to a style of mineralization lacking any of the indicators that miners look for when searching for pockets. The grain size of the pegmatite there is large, with giant K-feldspars and enormous quartz crystals. For example, the last pocket found in Dada's Tunnel in 2006, called the Giant Quartz Pocket, is appropriately right inside the core zone.

What the miners ran into was the core zone of this large and complex pegmatite, an area unlikely to produce pockets. This was good news to Federico and Andrea, leading them to hypothesize that a mirror-image area of productive pegmatite existed on the other side of the core zone. In order to test this theory it was necessary to make a new commitment to the mine.

Exploratory Drilling Program

The two geologists recommended that an exploratory drilling campaign be carried out to determine the boundaries of the main pegmatite body. We also needed to determine the exact distances between the tunnels, to connect the different pegmatite bodies that we knew existed, and to drill through the core zone and into the theoretical continuation of the pocket-rich area on the other side. If that area did indeed exist, we would want to measure its size, distance and configuration in order to design a mining plan.

This new drilling campaign was no small undertaking. It required the purchase of new machinery we had not used in the past, and it meant that we had to hire a professional drilling team headed by a geologist. The drilling machine alone cost over $200,000. After contemplating the project and evaluating its potential, we decided to take the plunge and go at the mine full bore, with a plan to define the pegmatite body and create real targets that we knew would yield results. The main focus, and the site of the first areas to be drilled, was Dada's Tunnel, and so Dada's Tunnel needed to be brought back up to full mining capability. This meant pumps, compressors, drills, dynamite, miners, water stores, piping, electricity, ventilation—the full program.

Federico and Andrea produced a Drilling Campaign Proposal and I purchased an Atlas Copco core drill—not a common machine, and one that is comparatively very compact. The model Diamec 232A is a small, "artisanal" core drill that can be used in small tunnels. The delivery time on the machine was quoted at eight weeks, but it took 14 weeks to arrive in New Jersey, and then we had to ship it to Brazil, which took another month.

Finally, by the end of July 2013, the machine was on site and ready for its first test run: drilling a single core sample. The machine's capacity is actually impressive for its size; it is able to drill holes 100 meters deep and deliver core samples from them. The machine has several components. There is the electric motor with pneumatic oil storage tank; a surge-protector; and the control panel. Speed of rotation, direction of rotation, drilling in, and retraction, are all controlled from this panel. The drilling rig itself has an upper and a lower drill head. A water pump pressurizes water that feeds all the way from the water tank to the power unit to the drill rig and to the cutting edge of the drill bit. All of these components need to operate in unison and with precision in order to cut efficiently, safely and swiftly. A good drilling campaign is ultimately measured by the cost per meter of core, and the length of time it takes to drill the amount of core necessary to give adequate sampling for interpretation.

It took a few days and some manipulation to get proper electricity, sufficient water for cooling, and all the necessary components configured so that we could test the drill. But on day three we were drilling core samples! It was a huge undertaking, and after six months of discussions, investments and planning the results of the test were eagerly anticipated by all.

At this point Dr. Dini proposed leading a group of three Italian drillers who had drilled thousands of meters with similar equipment in Italy. The drillers would work a total of about 70 consecutive days and would live at the mine, running the machine daily to drill a total of 600 meters of core samples during that time.

Unfortunately, with fall approaching and with the pre-exisiting commitments of nearly every person on the team, we had to postpone the first drilling campaign until after the 2014 Tucson Show. We were going to have to wait another six months before we could start the campaign. Mining had been ongoing in the lower tunnel ever since the mapping and cleaning had been completed in mid-2012, but with no success.

Even as optimistic as I was about the Pederneira mine and its potential, I could not really understand the true value of the core drilling program and the information it could provide. I was actually a little skeptical about its real usefulness in determining targets, but, knowing that I was out of my depth with regard to the geology and development of the pegmatite, I trusted in my two friends, whom I greatly respect, and faithfully followed their recommendations.

Finally in Tucson we all met and ironed out the details of the first drilling campaign. The drilling team, consisting of Andrea Dini, Gian Luca Bigoni, and Filippo Nerli, would descend on Pederneira, together with the owners and partners, and the whole gang would kick off the drilling project on April 4, 2014. Fabio Baio, another driller and geologist, relieved Filippo about halfway through the campaign.

While I was there overseeing the initial mobilization and the commencement of the campaign, I began to understand the real value this machine could provide. After a few days of drilling and seeing the cores recovered it was clear that this machine could be used in a strategic way to define the exact boundaries of the contact between the black quartz schist country rock and the white pegmatite with pinpoint accuracy. The drilling yielded hard data, and plotting them and correlating them to a series of drill holes, all on exactly the same orientation across a span of tunnel, was like being able to look at the mine walls with X-ray glasses.

The concept of defining an orebody and mining it with the knowledge of its breadth, orientation and volume is not a new one. In large-scale mining for coal, metals, oil and gas, these practices are employed every day. But for mining gem deposits or specimen-producing bodies, this is new territory. Typically miners follow the rock without really knowing where they are going, hoping to stay in a productive trend. What's new is employing techniques to determine the boundaries and mass of the orebody before mining it so you can greatly increase the likelihood of success in a relatively small mining project.

The first drilling campaign was a huge success, despite some snags during the first three weeks: for instance, the drill bits were not always able to cut efficiently through the very hard pegmatite, and the mine suffered intermittent power outages. The campaign ran to June 16, and in the course of those two months the drilling team was able to drill some 800 meters of holes, more than we had thought would be possible in the timeframe.

A drilling campaign involves not only drilling and producing core samples but also tracking the trajectory and orientation of the drill holes and managing the core samples themselves. If the sample order gets confused and is not correctly logged, the results could become useless. The geological data revealed must be interpreted as it relates to the known geology and the mining plan. Keeping up with these tedious tasks is vital if the whole project is not to fall into chaos.

Happily, Federico Pezzotta, Andrea Dini and the entire drilling team are professionals in every way, and executed the campaign with incredible attention to detail. Since June of 2014, Pezzotta and Dini have been at work interpreting the results of the first campaign and creating a proven model of the findings. They showed me parts of the discovery in Milan this summer and defined what information was still needed for a completely accurate understanding of the structure of the Pederneira pegmatite.

They concluded that a second drilling campaign was necessary in order to define the sizes and locations of future target zones in a fact-based and not just theoretical way. The other objectives of the overall campaign had been achieved in the first phase, and they supported exactly the theory the geologists had proposed regarding the location of the main body relative to the core zone, and why the miners had gone off-track.

Our next step is to begin mining in the area in Dada's Tunnel where the proposed path to the next productive zone lies. And simultaneously we have begun the second mining campaign. In mid-September we began mining in the tunnel in the area where we need to cross the core zone to reach a new productive area. On October 1 the second drilling campaign was initiated. The same team has arrived at the Pederneira mine and has begun drilling to fully prove the hypothesized model. Wish us luck!

Mine Life

Life at the Pederneira mine is rather simple, consisting of lots of hard work, good homemade food, and sleep to recharge. Miners work a long day that starts at 7 a.m. and runs through 4:30 p.m. with a one-hour lunch at 11 a.m. and a half-hour coffee break at 3 p.m.

We have a total staff ranging from 15 to as many as 20 people, depending on the day and what is going on at the mine. There are about ten miners working underground daily, each of them with different tasks. Some of them are drillers who spend grueling days behind jackleg drills. These drillers have trained assistants who help them while drilling holes and relieve them for stints when the drillers get too tired or feel burned out. Other workers are loaders and carters who remove the blasted schist or pegmatite and cart it out of the tunnel all the way to the mine dump. Others manage the

***Figure 66*. The Pederneira mining camp:**
(A) Dada's Tunnel portal
(B) Dada's Tunnel dump
(D) Dynamite storage sheds
(E) Miners' sleeping quarters
(F) Dilo's Tunnel portal
(G) Equipment storage
(H) Old dumps from Dilo's Tunnel
(I) Manjoka garden
(J) Main house (sleeps 20), Guard tower
(K) New dumps from Dilo's Tunnel
(L) Garden and chicken coops
Marco Lorenzoni photo.

Figure 67. **Miners at work outside Dilo's Tunnel in 2010. Marco Lorenzoni photo.**

water stores, pumps, dynamite and tools used underground. There are miners who manage the equipment on the surface and see to some equipment that is only used occasionally in the mine, from hand tools like screwdrivers and hammers up to air compressors, winches, diamond chain saws, hydraulic rock splitters, ventilating fans and generators. Most miners are trained in all of these duties, and responsibilities rotate constantly.

As mines go, the Pederneira mine actually enjoys quite good conditions. The tunnels are a very hospitable environment, at least when blasting is not under way; they are dry for the most part and their temperatures range from 55 to 65 degrees year-round. A minor amount of groundwater leaks into different areas of the mine, creating small "ponds." We pump the water from place to place inside the mine, generally into flooded tunnels that we no longer use. When we need water for pumps or for the core driller or diamond chain saw, we just tap one of these ponds or flooded tunnels and we have all the coolant we need.

Commercial-scale mining for specimens is not an easy endeavor, and most people have no conception of what it involves. The first requirement, of course, is the presence of a highly mineralized deposit (in this case a pegmatite) that is large enough to support a mining program. Most small mines targeting gem rough or specimens fail because the necessary coordination and teamwork are lacking, but at Pederneira teamwork is the name of the game. Everyone is important, beginning with the groundskeeper who maintains the crops and the roads and the security guards who protect us from would-be robbers and opportunists. Every job, no matter how small, is significant; people working together, cooperating toward a single objective, is what has made the mining project at Pederneira a success. When a tourmaline pocket is found, everyone benefits, because the miners, the cook, the security guards and the mine foreman all receive shares of the proceeds. That fact helps motivate the team and keeps everyone working toward the same goal, regardless of obstacles.

In addition to the miners, we have a full-time cook named Neuza who has been with us for almost 14 years now. Some of the meals she has prepared are legendary. At this mine you can eat quite a bit better than in the average mining camp. The fare is largely composed of food harvested from the land (talk about "farm to table"—the table is 30 meters away from the farm). We have our own garden, and a series of crops planted on the hillsides. We have three chicken coops with hundreds of chickens parading around the grounds, providing lean protein and plenty of eggs. The garden has a wide selection of vegetables, including tomatoes, lettuce, kale, carrots, potatoes and peppers, to name just a few. And seasonally we have bananas, papayas and mangos, all of which we cultivate ourselves. Our crops also include manjoka root, corn and (of course) beans, used to make *feijão com arroz* (beans with rice) or *feijoada*, which has been described as the national dish of Brazil. Brazilian *feijoada* is prepared with black beans and a variety of salted pork or beef cooked into a stew and served over rice; done right, it is *delicious*.

In 2002 the M. Pederneira partnership lobbied the local municipality to bring electricity directly to the mine. An electric pole was erected and fitted with a large transformer that has been there ever since. Except for a few months after the transformer had been fried by a lighting strike during a storm, the mine has had the benefits of electricity. So miners have access to television, electric lighting in their quarters, hot water, refrigerators and all the benefits electricity affords. The benefits extend underground as well, where the tunnels are all well-lit, pleasant to work in, and quite easy to navigate. We have a phone at the mine that can make international calls and works probably 90% of the time, which is great, and in April of 2014 we outfitted the mine with Internet service. It took a few months to debug and get operating consistently, but we got it dialed in and the service is acceptable.

Sleeping quarters are modest but clean and comfortable. The main house can sleep up to 20 people in about six rooms, and there are four bathrooms fully equipped with showers and hot water. Miners have their own quarters at the mine camp, but most of them live nearby and prefer to go home each evening to their wives and families.

***Figure 68*. Miners relaxing on break outside Dilo's Tunnel. Marco Lorenzoni photo.**

***Figure 69*. The Dilo's Tunnel portal. Andrea Dini photo.**

***Figure 70*. The only telephone in the mining camp. Daniel Trinchillo photo.**

***Figure 71*. The author and Chris Vaughn at work in the "everything room" at the mine—serving as the dining table, breakfast table, meeting table, working table, and lounge . . . it's the everything table. Alexis Talbot photo.**

Figure 72. **Daniel, Zé, Adeclides and Junio discussing targets and mining strategies. Bryan Swoboda photo.**

Figure 73. **The tunnels at the Pederneira mine are well lit and for the most part dry and easy to navigate. Bryan Swoboda photo.**

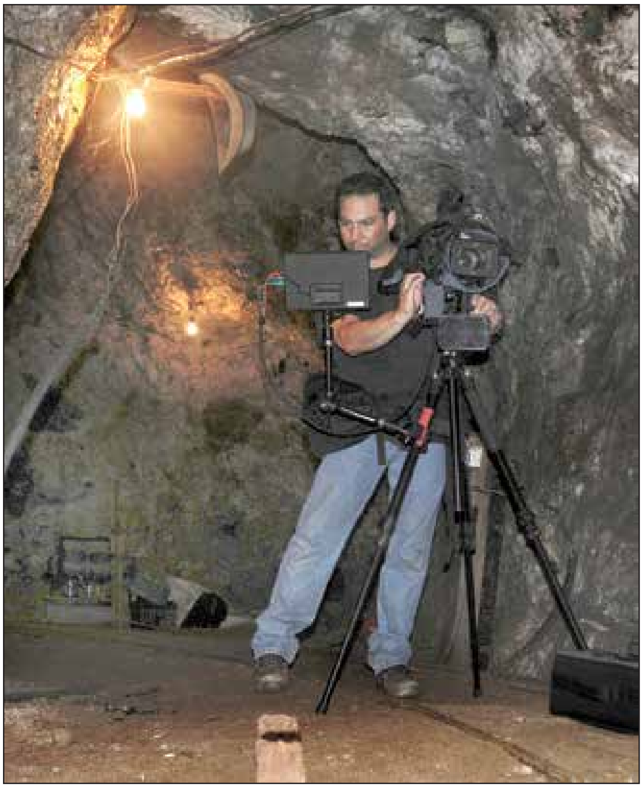


Figure 74. (above) **Bryan Swoboda preparing to shoot video underground for a documentary DVD. Marco Lorenzoni photo.**

Figure 75. **(*above left*) The author negotiating a narrow bridge over a 50-foot drop. Alexis Talbot photo.**

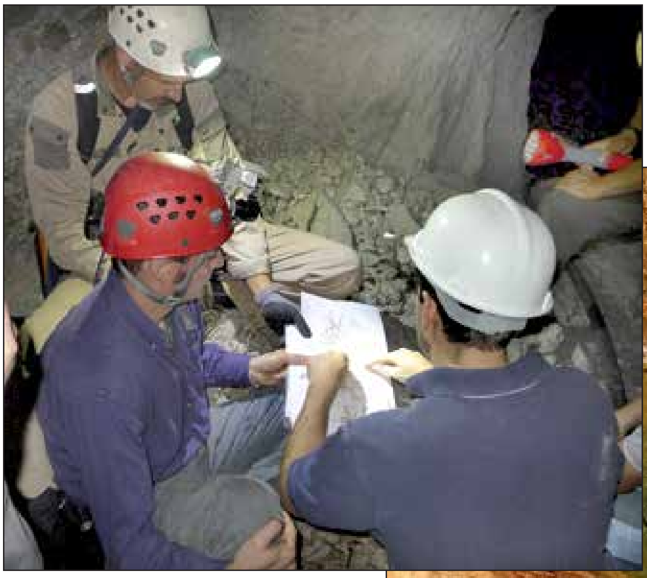


Figure 76. **Strategy meeting underground. Chris Vaughn photo.**

Figure 77. **Underground catchment basin where water is collected for use elsewhere in the mine and the above-ground facilities. Bryan Swoboda photo.**

***Figure 78*. Miners loading ore cars with waste rock for transport to the dump.**

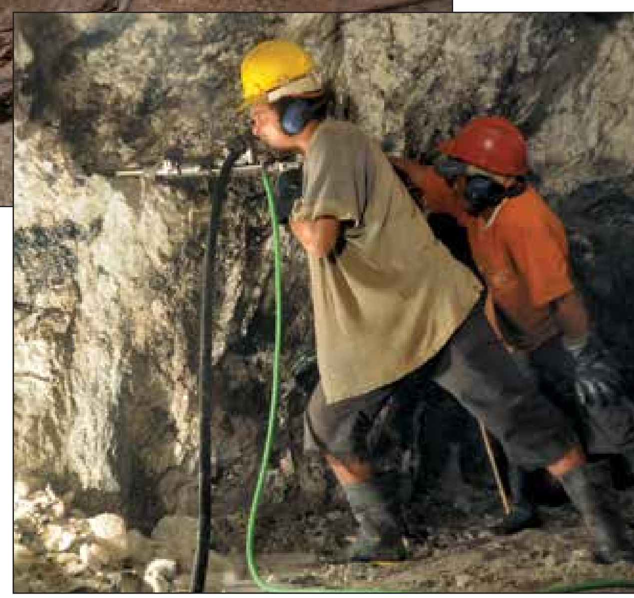


***Figure 79.* Ju and his assistant hard at work in Dilo's Tunnel. Andrea Dini photo.**

***Figure 81*. Elci with the pneumatic rock splitter used for gently opening pockets. Andrea Dini photo.**

***Figure 80*. (*below*) Daniel translating Pezzotta and Dini's theories into Portuguese for Thiago, Junio and Elci. Chris Vaughn photo.**

Figure 82. **Nezinho (miner). Fabio Baio photo.**

Figure 83. **Carranca (miner). Fabio Baio photo.**

Figure 84. **Paolo (miner). Fabio Baio photo.**

Figure 85. **Scoob Doo (miner). Fabio Baio photo.**

Figure 86. **Carranca (left) and Fabio Baio. Gian Luca Bigoni photo.**

Figure 87. **Gian Luca Bigoni (one of the drilling team) and Elci. Fabio Baio photo.**

Figure 88. **Neuza (the mine camp's full-time cook) and Gian Luca Bigoni. Fabio Baio photo.**

Figure 89. **Zé Menezes and Burkhard Pohl in Neuza's kitchen.**

Figure 91. **Future chicken dinners in the mine camp's chicken coop. Alexis Talbot photo.**

Figure 90. **A future chicken dinner. Bryan Swoboda photo.**

Figure 92. **Dinner in preparation in Neuza's kitchen. Daniel Trinchillo photo.**

Figure 93. **The mine camp's garden for fresh vegetables. Daniel Trinchillo photo.**

Figure 94. **Garden-fresh salads and bacon-wrapped filet mignon for the staff. Alexis Talbot photo.**

Figure 95. **Fresh tomatoes, onions and other vegetables from the garden. Andrea Dini photo.**

***Figure 96*. The home of one of the miners adjacent to the Pederneira mine. Marco Lorenzoni photo.**

***Figure 97*. Local residents. Marco Lorenzoni photo.**

***Figure 98.* (*middle left*) Electrical transformer erected by the local municipality (2002) bringing light and power into the mining camp.**

***Figure 99*. Another local resident. Marco Lorenzoni photo.**

Geology

by Federico Pezzotta and Andrea Dini

REGIONAL GEOLOGY

Pederneira pegmatites are part of the Eastern Brazilian Pegmatite Province. This province, the Sierra Pampeanas (Argentina) Province and the Sierra Borborema (Brazil) Provinces, constitute the three main pegmatite provinces in South America (Putzer, 1976). The Eastern Brazilian Pegmatite Province is situated mainly in the State of Minas Gerais but also overlaps into the southern part of the State of Bahia, the western margin of the State of Espirito Santo and the northern part of the State of Rio de Janeiro (Paiva, 1946; Putzer, 1976; Correia Neves *et al*., 1986).

The Eastern Brazilian Pegmatite Province is part of the so-called Araçuaí Orogen (which formed between 630 and 480 million years ago), one of many Brasilian/Pan African orogens formed during the Neoproterozoic-Cambrian assembly of the Gondwana supercontinent. Thanks to the wealth of geological and petrological studies now available, the geotectonic setting of the Araçuaí Orogen seems to be relatively well-established (e.g. Pedrosa-Soares *et al*., 2008). This orogen extends from the eastern border of the São Francisco craton to the Atlantic margin of southeastern Brazil. Together with the West Congo belt of west-central Africa, the Araçuaí Orogen forms a late Neoproterozoic-Cambrian orogenic edifice confined to an embayment surrounded by the Archean-Proterozoic, São Francisco-Congo craton.

The most remarkable feature of this crustal segment is the huge amount of different plutonic igneous rocks of Late Neoproterozoic up to Cambrian and Ordovician ages, representing a long-lasting succession of granitic intrusive events. Based on field relations, structural features, geochemical and geochronological data, granites from this orogen have been grouped into five supersuites (G1, G2, G3, G4 and G5) by De Campos *et al*. (2005) and Pedrosa-Soares *et al*. (2008). Granitic rocks cover one third of the orogenic region, and have built up the Eastern Brazilian Pegmatite Province. At least a thousand pegmatites have been mined in this province since the beginning of the 20th century, producing gems (tourmalines, beryl and spodumene varieties, garnets, topaz, and others), tin, lithium and beryllium ores, industrial minerals (mainly feldspars and muscovite), and rare minerals (phosphates, oxides of tantalum, niobium, tin, tungsten, uranium and other elements), including a great many collector-quality crystal specimens.

In the Araçuaí Orogen, the most important pegmatite populations in the Eastern Brazilian Pegmatite Province can be subdivided into eleven districts (see Pedrosa-Soares *et al*., 2011 and references therein), based on their mineralogical contents, pegmatite sizes, types and classes, and relations to parent and host rocks. Most pegmatites of the Araçuaí, Ataléia, Conselheiro Pena, Espera Feliz, Padre Paraíso, Pedra Azul, Malacacheta and São José da Safira districts have been interpreted as differentiated products from granite intrusions. Anatectic pegmatites prevail in the Caratinga, Santa Maria de Itabira and Espírito Santo districts where they are considered as products of partial melting of paragneisses.

In economic terms, the differentiated pegmatites are much more important than the anatectic pegmatites, and their parent intrusive rocks belong to the syn-collisional G2 (Conselheiro Pena district), post-collisional G4 (São José da Safira and Araçuaí districts) and G5 (Ataléia, Espera Feliz, Padre Paraíso and Pedra Azul districts) supersuites. Pegmatites hosted by metamorphic rocks surrounding the intrusions are the most important mineral deposits in the Araçuaí, Ataléia, Conselheiro Pena and São José da Safira districts, while granite-hosted pegmatites largely predominate in the Espera Feliz, Padre Paraíso and Pedra Azul districts.

LOCAL GEOLOGY

The Pederneira pegmatites, together with a number of other famous pegmatites (Cruzeiro, Aricanga, Golconda, Jonas) belong to the São José da Safira district. This district mainly includes pegmatites related to the post-collisional, S-type granites of the Santa Rosa suite (G4 supersuite), and also beryl-muscovite-rich pegmatites apparently without any relation to a parent granite (but most likely related to unexposed G4 intrusive granites). The main host rocks are garnet-mica schists with variable contents of staurolite, kyanite, sillimanite, garnet-biotite, paragneisses and quartzites. Most pegmatites are large, complexly zoned bodies with a boron-beryllium-lithium enrichment and abnormal contents of muscovite, albite, schorl, elbaite and beryl with accessory minerals like niobium-tantalum oxides, pyrochlore-group minerals etc. (e.g. Federico *et al.,* 1998; Castañeda *et al*., 2000; Dutrow and Henry, 2000).

At Pederneira, two main pegmatite bodies (Dilo and Dada) crop out in a small lateral valley of the Córrego da Pederneira at an elevation of about 700–750 meters. Host rocks include biotite-quartz (garnet) mica schists showing a pervasive east-west-trending schistosity dipping gently to the south.

The Pederneira pegmatites were discovered and exploited from exposed outcrops but the complex geometry of the pegmatites and the lack of continuous surface exposures (because of vegetation, soils, lateritic covers, etc.) prevented a full understanding of their geometry and attitude. Recently, a detailed topographic survey coupled with a still-ongoing exploration campaign (geological mapping and core-drilling) have provided important data to help establish the geometry and the orientation of the two Pederneira pegmatite bodies.

The Pederneira pegmatites are two sub-parallel tabular bodies, almost concordant with the host-rock schistosity, and separated by a mica schist septum of about 20 to 30 meters in thickness. Each pegmatite body is generally relatively thin (about 50 cm to 2 meters) but locally the thickness can reach 15 meters in an area of inclined columns that have provided most of the gem and specimen production. Pegmatite in sub-horizontal sections is characterized primarily

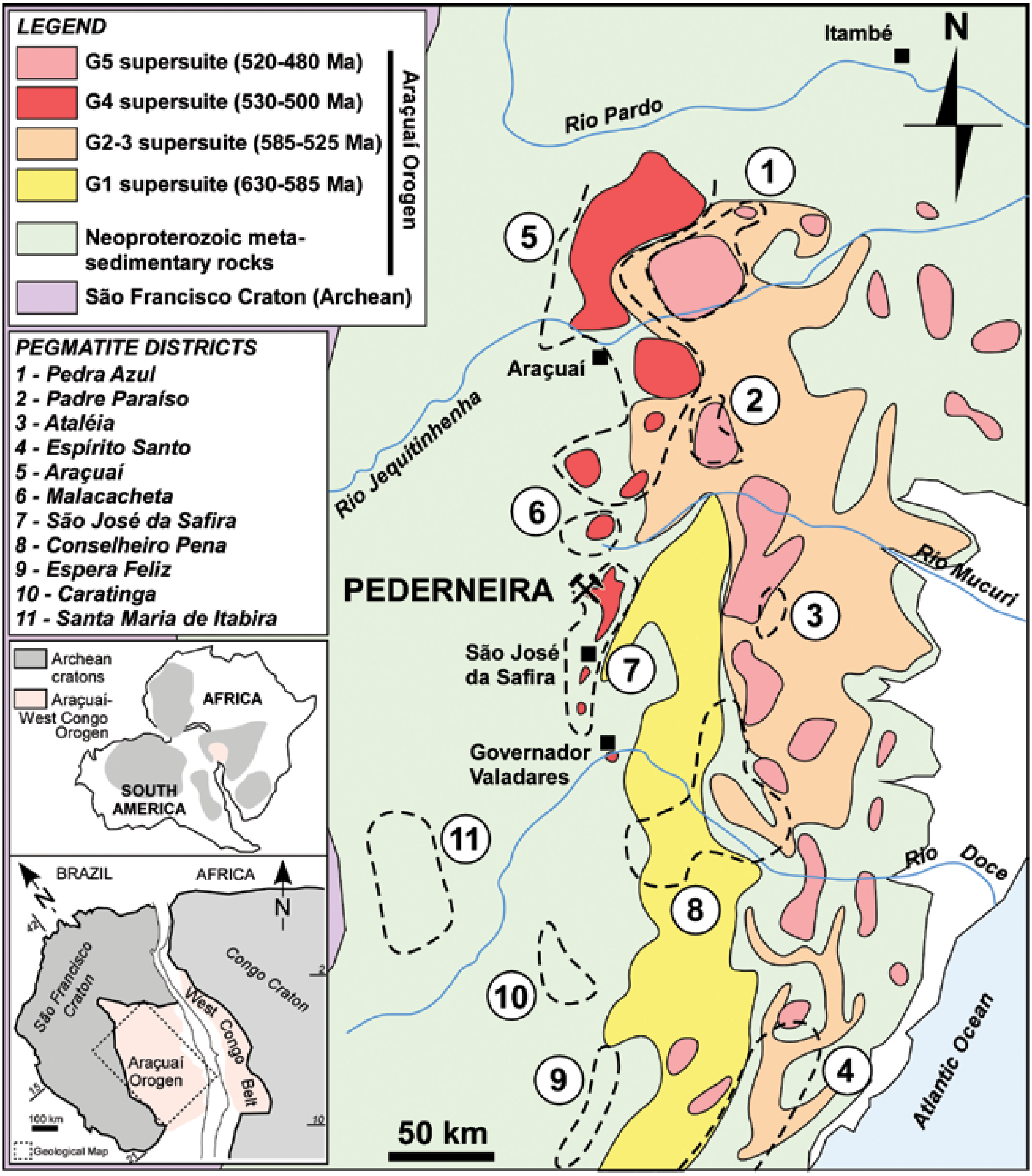


Figure 100. **Regional geology in the Eastern Brazilian Pegmatite Province, with important localities noted.**

by quartz and feldspar with abundant biotite, muscovite and scarce black tourmaline and garnet. In the inclined, enlarged columnar sections the structure and mineralogy of the pegmatite change abruptly: biotite usually disappears while tourmaline becomes a major component together with garnet and muscovite.

Geological mapping in nearby artisanal workings (*garimpos*) such as the Paolo Vasconcelos, Domingo Venancio and Cabo Murilo tunnels indicates that the Dilo and Dada pegmatite bodies have a lateral continuity of several hundred meters. Moreover, exploratory drill holes have already intersected new large columns in zones never reached by previous mining activity. Both of these results (lateral continuity and existence of other columns) indicate that at Pederneira and nearby areas there is still some potential for further production.

Adoption of a modern exploration protocol (mapping and drilling coupled with petrographic and geochemical study) is quite new in Brazilian *garimpos* but it is the best approach for the evaluation of the real economic potential of this pegmatite district.

PEGMATITE STRUCTURE AND PARAGENESIS

In May of 2010 one of the authors (FP) visited the Pederneira mine to determine whether a new geological investigation might prove useful in locating new productive areas in the mine. The first step was to learn from the most experienced miners all of the

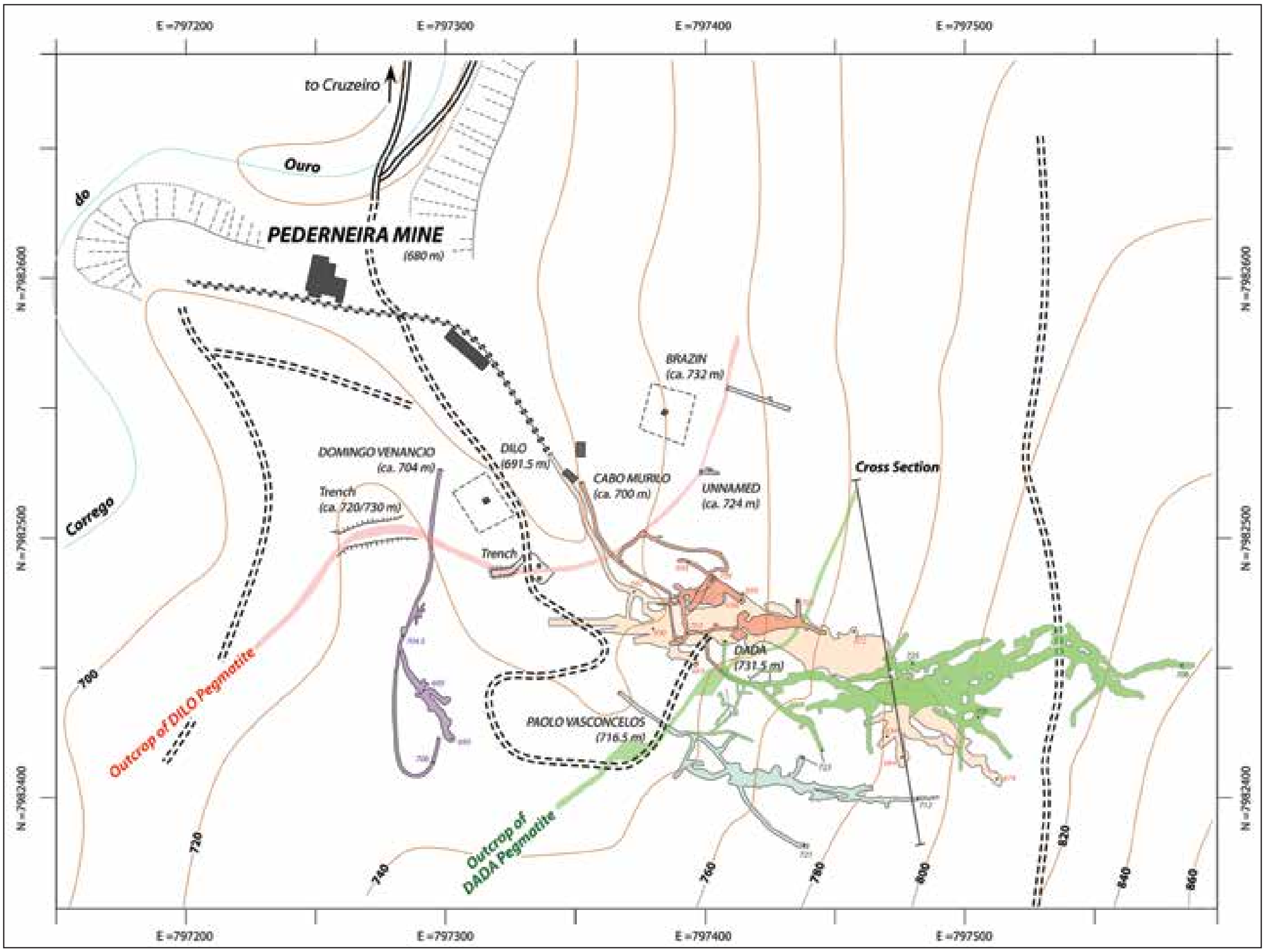


Figure 101. **Plan view of underground workings in the Pederneira mine.**

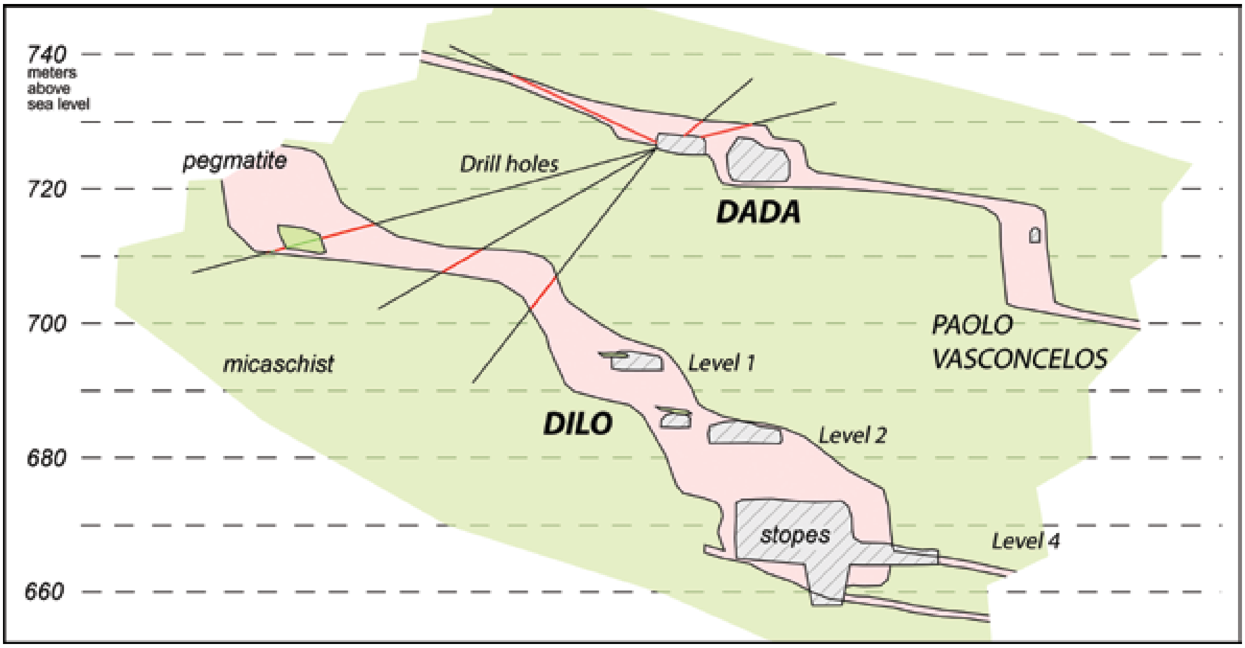
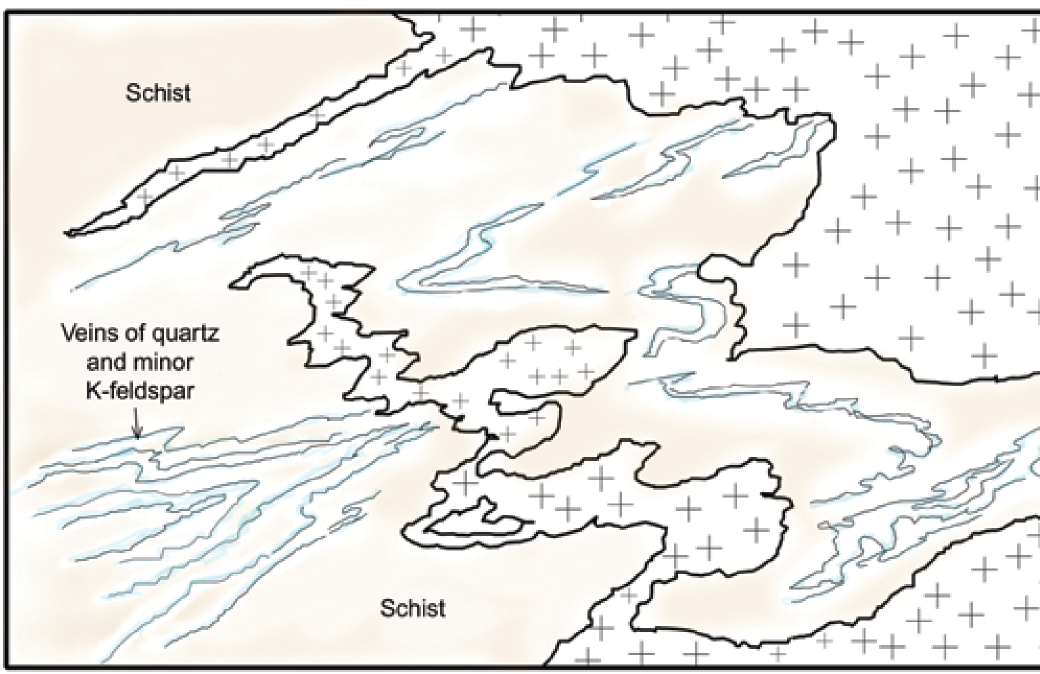


Figure 102. **Cross section through the Dada and Dilo workings.**

Figure 103. **Typical contact between pegmatite and hosting biotite-garnet schist at Pederneira. Dilo's Tunnel. Federico Pezzotta photo.**

Figure 104. **Interpretative drawing of the outcrop reported in Figure 103. Pegmatitic rock is indicated by (+), schist by pale brown color, and quartz veins (locally with grains of feldspars) by pale blue.**



information they had collected during the many years of activity. The first important question was: Were the previously mined pegmatites oriented horizontally or more vertically? Some of the miners answered "horizontal!" while others answered "vertical!"

The Dilo and Dada pegmatites were known to be two distinct productive zones, but it was as yet unknown if they were two distinct pegmatitic bodies or if they were part of the same one, if they were interconnected at some level, and what their spatial relationship was to the other veins cropping out in other *garimpos* in the nearby area. This was for us the beginning of a very intriguing geological study and, as expected, the answers to all of these open questions did not come easily and required careful geological, petrographic and structural mapping, coupled with the valuable new detailed topographic mapping of the underground workings made by Marcelo Viera Campos.

As reported in the previous paragraph and illustrated in the map and geologic interpretative sections, the Dilo and Dada tunnels have been mined along two distinct productive zones belonging to two distinct pegmatite bodies. In both cases, productive zones occur in sectors where the tabular pegmatitic bodies change attitude from sub-horizontal to rather vertical, forming elongated prismatic bodies with thicknesses exceeding 15 to 20 meters.

The contact between the pegmatites and the hosting biotite-garnet schist is sharp and is locally complicated by abundant pegmatitic veinlets penetrating the schist and by abundant schist enclaves hosted in the pegmatitic rock. Such structures are interpreted as being related to the mechanism of emplacement of the pegmatitic magma into the hosting schist. The magma was emplaced in an extensional tectonic environment at relatively low pressures (below 3 kilobars, corresponding to less than 10 kilometers of depth into the crust). The schist fractured primarily by delaminating along the schistosity plane; it was simultaneously intruded by pegmatitic magma propa-

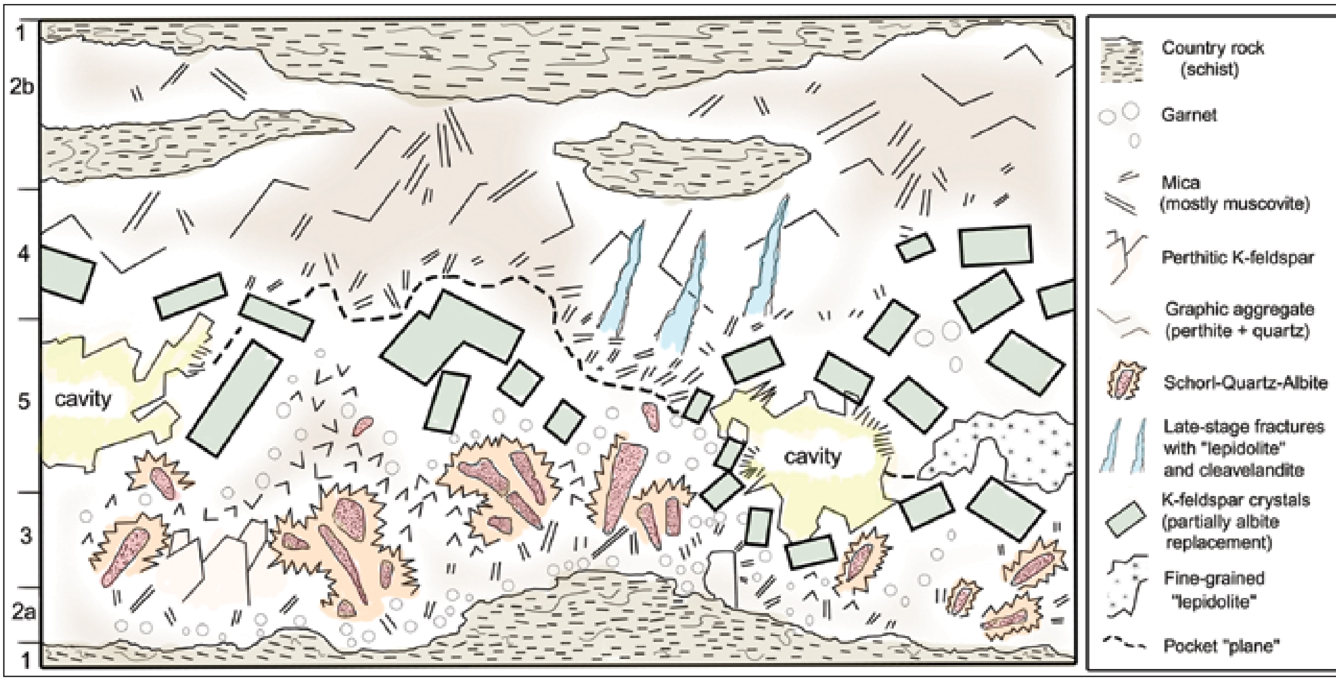


***Figure 105*. Interpretative section of a gem-productive sector of the Dilo pegmatite. (1) Hosting schist rock; (2a) lower border zone; (2b) upper border zone; (3) lower intermediate zone; (4) upper intermediate zone; (5) core zone.**

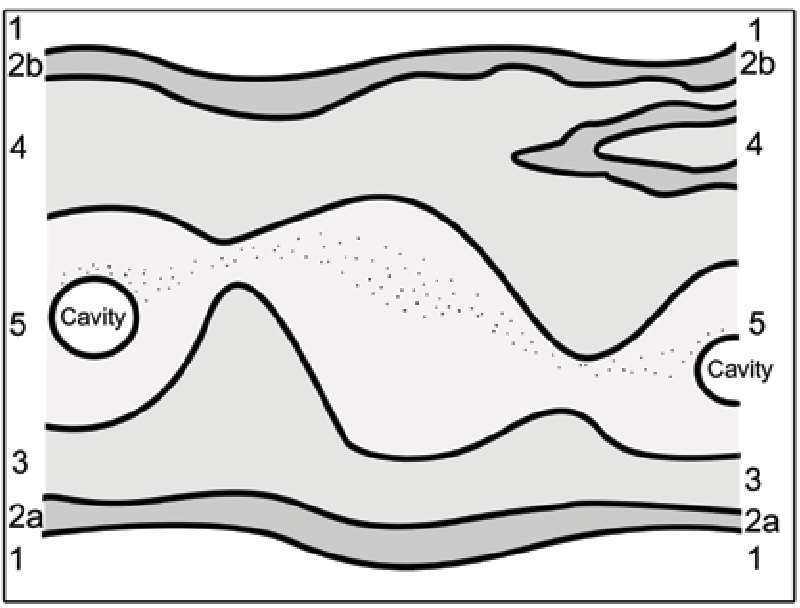


***Figure 106*. Simplified section of a gem-productive sector of the Dilo pegmatite. Units as illustrated in Figure 105.**

gating along the fractures. The metamorphic folds of the schist were deformed by the stress of the fracturing/delaminating process and by the forceful intrusion of the magma, created new disharmonic folds locally penetrated by the pegmatitic magma, thereby creating rock structures similar to those of metamorphic migmatites.

The pegmatitic veins in the sub-horizontal tabular sectors, which are typically from a few tenths of a meter up to about 3 to 4 meters in thickness, are in general poorly zoned. Geochemical complexity is relatively low, with most of the volume of the rock characterized by quartz, feldspars and biotite. The following zones can be observed, from top to bottom:

(1) Unaltered schist country rock hosting the pegmatite.
  (1b) Exocontact zone of the schist country rock.
(2b) Upper (hanging wall) border zone.
(4) Upper intermediate zone.
(5) Core zone
  (5a) Upper core zone.
  (5b) "Pockets plane."
  (5c) Lower core zone.
(3) Lower intermediate zone.
(2a) Lower (foot wall) border zone.
  (1a) Exocontact zone of the schist country rock directly.
(1) Unaltered schist country rock hosting the pegmatite.

Border zones, both at the hanging-wall and the footwall of the vein, measure from a few centimeters up to a few tenths of a meter in thickness, and are characterized by medium-grained quartz-feldspathic rock, rich to very rich in biotite blades.

The ***lower intermediate zone***, 50 cm to over a meter thick, is composed of coarse-grained quartz-feldspathic rock, and contains tapering biotite crystals and local enrichments in schorl and rarely in spessartine garnet.

The ***upper border zone***, 20 cm to a meter thick, is a mostly

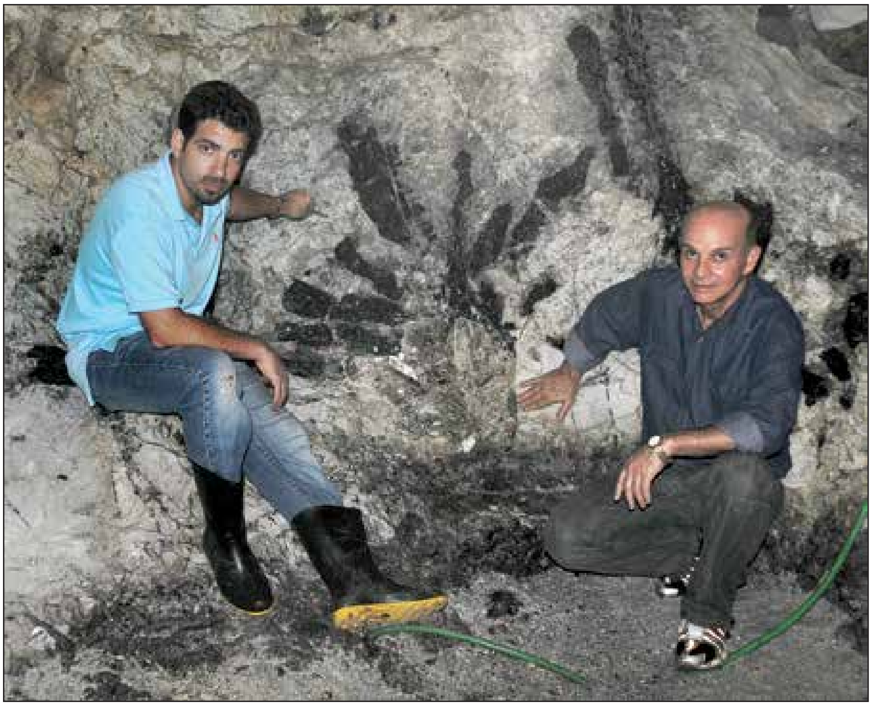


Figure 107. **Daniel and Zé Menezes sitting in front of the area where Thiago's Pocket was discovered. Note the large, embedded black tourmaline crystals.**

Figure 108. **Spectacular outcrop, about 5 meters across, in Dilo's Tunnel, showing several black tourmaline aggregates, similar to the ones illustrated in Figures 110 and 112, disposed in radial groups projecting from the border zone into the core of a large pegmatite.**

feldspathic unit containing rare biotite and schorl, with occasionally large quartz-perthite (mesoperthite) aggregates.

A rare, small (4) ***core zone*** characterized by minor masses of cleavelandite and small, fine-grained masses of lepidolite is sandwiched between the upper and lower intermediate zones.

Rare accessory minerals such as apatite (presumably fluorapatite) and beryl can be present, dispersed in the two intermediate zones, and Nb-Ta oxides can be found dispersed in all units.

Cavities are rare to very rare and can be present in all units, from the border zones to the core zone. In general, the cavity mineralogy is primitive, with quartz crystals, albite (cleavelandite variety in the core zone) and microcline, together with more or less corroded crystals of biotite/zinnwaldite and muscovite, schorl, local spessartine, dispersed crystals of pale colored apatite (white to pink, presumably fluorapatite), and cassiterite. Very rarely, miarolitic cavities occurring in the limited, geochemically highly evolved core zones, can produce very high-quality gem-grade crystals of tourmaline of green to blue color.

Pegmatitic masses in large sub-vertical sectors have well-defined pegmatitic zoning, locally with spectacular rock textures and with very high geochemical evolution in the core zone. Diagrammed here is a typical, well structured section of a large, gem-rich pegmatite vein, dipping at a high angle, intersected by the Dilo tunnel.

Unit number 1 in the diagram is the schist host rock. In the ***exocontact zone*** directly adjacent to the pegmatite, the schist locally displays some coarsening of the size of the biotite crystals and of

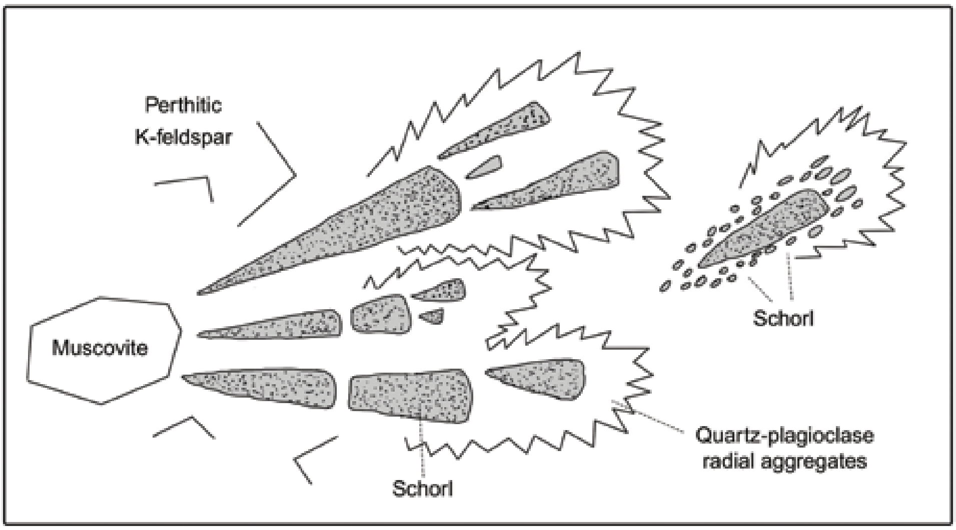


***Figure 109*. Schematic representation of some typical schorl aggregates occurring in pegmatite veins at Pederneira, and their relation with other rock-forming minerals.**

***Figure 110*. Axial section of a large schorl crystal embedded in pegmatite. Growth began on the right side; then a second generation of growth started from three points on the termination. A third growth stage is represented by the fine-grained schorl-quartz aggregates around the large crystals. Dilo's Tunnel, Pederneira mine; Federico Pezzotta photo.**

***Figure 111*. Cross section of a schorl crystal rimmed by a quartz-schorl graphic aggregate, about 25 cm across. Dilo's Tunnel. Federico Pezzotta photo.**

***Figure 112*. Black tourmaline aggregate (schorl) similar to the ones illustrated in Figures 110 and 111. This picture better illustrates the rim of the aggregate, composed of a relatively fine-grained texture of tourmaline and quartz.**

the quartz grains, and some centimeter-size black tourmaline crystals (very likely of dravite composition). Pegmatitic veinlets locally protrude from the dike into the schist along or across the plane of schistosity. Schist blocks can frequently be present as enclaves close to the contacts with the pegmatite veins. More rarely, enclaves of very large size (up to many meters in length) can be present inside the pegmatite body, affecting the geometry of the pegmatitic units.

The ***border zones*** of the pegmatite, with a thickness of 1 to a few tenths of a meter, are identified with numbers **2a** (at the footwall of the vein) and **2b** (at the hanging wall of the vein). This is a medium-grained unit rich in quartz (to over 50% in volume) and mica (ranging from about 10 to 40%) which in general is muscovite and only rarely biotite. The remaining volume is perthitic feldspar and very minor plagioclase (probably very sodic) grains. Red spessartine is present as an accessory at the footwall unit.

The ***lower intermediate zone*** (unit number 3) can range in width from 1 to several meters. From the bottom to the top the following structures can be observed: a coarse-grained band to over 2 meters

Figure 113. **Large multicolored tourmaline crystal frozen in quartz near the pocket plane in the core zone in the Dilo's Tunnel. Andrea Dini photo.**

Figure 114. **Large mass of fine-grained purple lepidolite in the core zone of the Dilo pegmatite, together with large, cream-colored K-feldspar crystals partially replaced by white to pale blue albite. Federico Pezzotta photo.**

Figure 115. **Spectacular exposure in Dilo's Tunnel showing the complex mineralogy of the core zone of the pegmatite: coarse-grained quartz and feldspars with albite (pale bluish color), "lepidolite" (fine-grained masses of violet color); spodumene (tapering crystals, partially replaced by very fine-grained lepidolite and probably montmorillonite, of pinkish color), and dark brown to black Mn-hydroxides formed by the alteration of Mn-rich phosphates.**

thick composed of abundant quartz, perthitic K-feldspar and large prismatic crystals or crystal aggregates of black tourmaline (up to 1 meter long), sometimes disposed in radial groups. Such tourmaline crystals can display several different textural peculiarities from several stages of crystal growing. Figure 110 shows the case in which the tourmaline aggregate starts close to the border of a large muscovite blade, projecting to the center of the pegmatite, forming a first crystal several tenths of a meter long, at the top of which, several new crystals have developed. The termination of the tourmaline aggregate is rimmed by a radial aggregate composed by medium-grained quartz and albitic plagioclase. Figure 112 shows a tourmaline aggregate in which a large central crystal is rimmed by a graphic quartz-tourmaline texture, rimmed at the top by a quartz-plagioclase radial aggregate. Other similar cases are also illustrated here. The tourmaline-rich band (medium-grained; grain size around 3 to 4 cm) has variable lateral thickness, from a few centimeters up to over 1 meter. This unit is composed of quartz, albitic plagioclase and perthitic K-feldspar. Quartz is milky white at the bottom of the unit and turns to a pale smoky color at the top, albitic plagioclase is very pale blue and perthitic K-feldspar is pale pink. This unit is rimmed at the top by a well-defined band rich in spessartine in crystals generally of 2 to 3 cm in diameter. This garnet band shows nice undulations, evidencing strong lateral thickness variation of the lower quartz-feldspathic band. Schorl-quartz aggregates up to 20 cm and dispersed muscovite blades up to 10 cm in diameter can be present. This band can locally be crosscut by tiny fractures filled with fine-grained purple "lepidolite" and tiny prisms of bluish tourmaline, projecting down from the core zone of the pegmatite.

The ***upper intermediate zone*** (unit number 4) can be from 1 meter up to several meters thick; it is composed of very coarse-grained quartz and perthitic K-feldspar in similar proportions. Perthitic K-feldspar can form very large crystals (to over 1 meter in diameter, characterized by well-developed graphic textures with quartz. Muscovite can be locally abundant, forming large blades, occasionally with garnet inclusions. Schorl can be present in large single crystals, radial groups or graphic aggregates, in some cases similar to the ones of the lower intermediate zone, even if not as abundant and persistent. Locally, this unit is traversed by long and occasionally thick fractures projecting up from the core zone of the pegmatite, rich in fine-grained purple lepidolite, albite of the cleavelandite variety, bluish tourmaline, and accessories such as cassiterite and Nd-Ta oxides.

A pegmatitic ***core zone*** (unit number 5) is present between the lower and the upper intermediate zones. This unit can be 30 cm to several meters thick and is roughly divided into *lower core* and *upper core* zones by an idealized "pockets plane."

The ***lower core zone*** is, in general, relatively thin (one to several tenths of a meter thick), medium-grained and composed mostly of quartz, sugary albite masses, cleavelanditic albite, and fine-grained flakes of lepidolite. It mantles the undulating contact with the lower intermediate zone. Some large tourmaline crystals originating at the level of the garnet-rich band in the lower intermediate zone have been found to project up into the lower core zone.

The ***upper core zone*** can be up to several meters thick, and is typically characterized by giant, cream-colored, perthitic crystals of K-feldspar (up to 2 meters in diameter), partially replaced by bluish sugary albite or cleavelanditic albite.

The upper core zone is also composed of masses of gray to smoky quartz, sugary albite, and granular purplish lepidolite. Niobium-tantalum oxides, pyrochlore group minerals, cassiterite, helvite and phosphate masses (apatite, hydroxylherderite and others) can be present as accessory minerals. In proximity of the pocket plane, multicolored tourmaline in crystals frozen in quartz and albite are ubiquitous. Large, tabular, orange to pink beryl crystals can be present but are rather uncommon.

In the upper levels of the Dilo Tunnel, a large core zone many meters thick has been exposed by mining. No significant crystallized cavities have been found in this area, but more complex mineralogy and more complex late-stage hydrothermal development is in evidence. In this area the rock is locally rich in large spodumene crystals which have been heavily replaced by clay minerals, fine-grained lepidolite with pink tourmaline, and large phosphate masses and crystals which have been more or less altered, associated with rhodochrosite, pyrite, apatite (presumably fluorapatite) and other minerals. (Green spodumene has been found only in the lower tunnel and only in two specimens thus far.)

A rather continuous band of large books of muscovite is present near the top of the upper core zone; this mica-rich level can sometimes penetrate down into the upper core zone and in some places has become dispersed into it. But in other areas, between this muscovite-rich level and the upper core zone there is a level from 10 to 60 cm thick composed of medium-grained quartz and pale bluish albite, occasionally with some garnet crystals.

Geochemically high-evolved cavities with lepidolite and multicolored tourmaline are confined to the "pocket plane" separating the upper and lower core zones. Cavities of a much lower degree of chemical complexity and smaller size can occasionally be found in the other units of the pegmatite. The pocket plane is typically very undulating as it follows the pinching and swelling of the core zone. Depending on the information reported by the miners who worked in the most productive volumes of the Dilo and Dada pegmatites, it seems that in some of the largest masses of the core zone, the pegmatitic textures were rather chaotic with more than one pocket plane, or a "thick" pocket plane with cavities developing at various levels in it.

The distribution of the pockets found in the Dada Tunnel is shown in the accompanying diagram which roughly illustrates the zoning of the Dada pegmatite in a horizontal section. These pockets have been found at different levels in the pegmatite body but their position has been projected on the same plane in this figure. The map shows how the Dada Tunnel actually encountered two different core zones. These pockets were considered by the miners to be "the end of the line" but may instead belong to a second core zone having production potential.

Figure 116. **Large phosphate crystal (probably hydroxylherderite) in quartz and feldspars in the core zone in the Dilo's Tunnel. Federico Pezzotta photo.**

POCKET STRUCTURES AND POCKET MINERALS

In the Pederneira pegmatites, crystallized cavities are generally found filled by minor amounts of clay, but some are encountered without any clay at all inside. This is rather unusual, because in many other pegmatites in the world, cavities tend to be partially or completely filled by clay. Nevertheless, in general, the larger pockets are more likely to be found collapsed. In many cases, when a pocket is exposed by the miners, the collapse has left fresh rough rock at the roof and a large pile of broken fragments below. When the miners begin removing the pile of broken rubble, it quickly becomes apparent that it hides magnificent crystals, and the very delicate and careful work of extraction begins, requiring from a few hours up to a month.

In general, the collapse involves the largest and heaviest crystals formed at the roof of the cavity. As they fall down (perhaps through fluid), they damage some of the crystals formed at the sides and bottom of the cavity. It is surprising that, even in such a "disaster," many crystals and crystal groups remain unbroken and occasionally even on matrix.

After very careful removal of all the loose crystals and fragments, a diamond chain saw is used to remove from the sides and bottom of the cavity many matrix crystal groups with the most robust

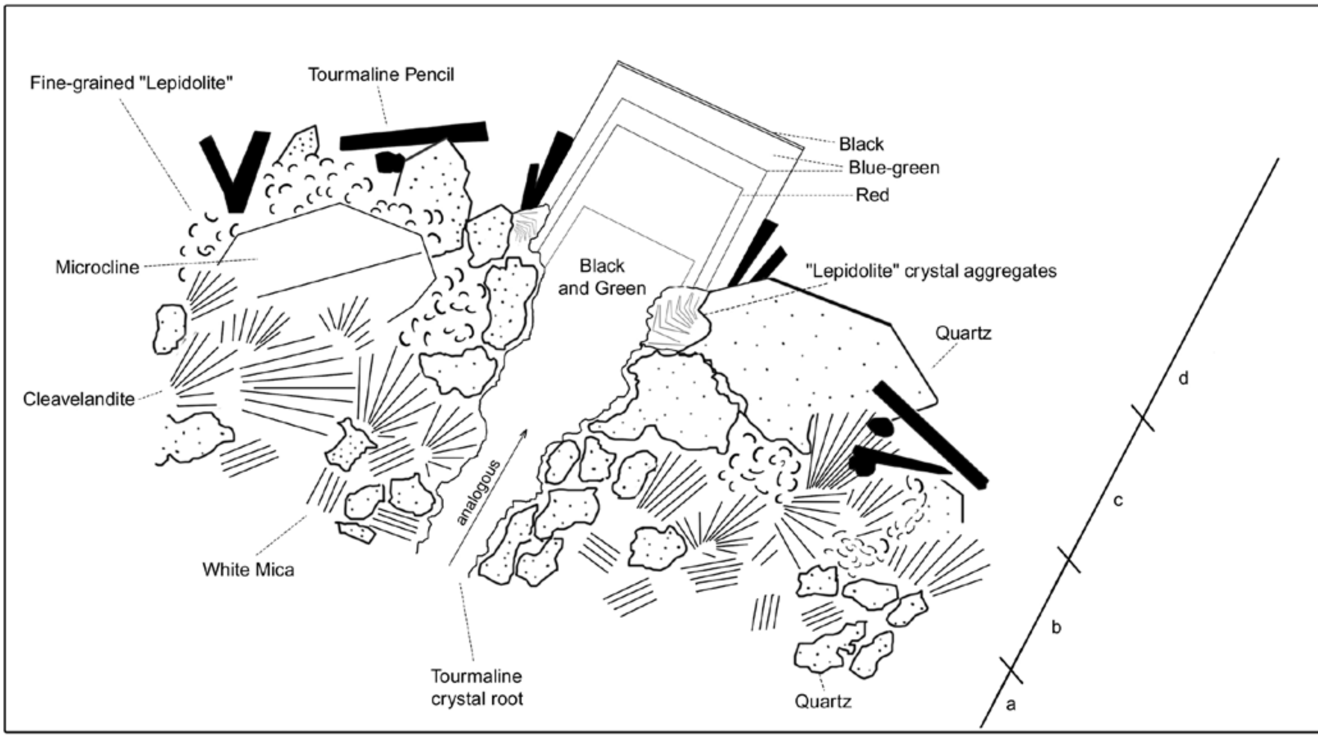


***Figure 117*. Schematic representation of rock and mineral textures developed in and around a gem-bearing miarolitic cavity at Pederneira. (a) Transition between the lower intermediate zone and the lower core zone; (b) lower core zone; (c) pocket minerals; (d) open cavity.**

tourmaline crystals still attached, and the connection points where many delicate, loose tourmaline crystals can be perfectly reattached in specialized laboratories.

Also illustrated here (Fig. 117) is a typical structure observed in a highly geochemically evolved gem pocket in the Pederneira mine. This particular drawing has been inspired by a large specimen removed from the bottom of a large pocket in the Dada Tunnel. The bottom of the drawing (a) represents the contact between the lower intermediate zone and the lower core zone of the pegmatite. A large tourmaline crystal with an analogous termination is protruding from the lower intermediate zone into the lower core zone and up into the cavity. This type of crystal, which is deeply rooted in the pegmatite, represents a first generation of tourmaline crystallization colored black (schorl) at the base and changing to multicolored (elbaite composition) toward the cavity. The lower core zone unit (b) is medium-grained with quartz, sugary albite, cleavelanditic albite and muscovite. Near the cavity the grain size of the minerals dramatically increases and K-feldspar and granular masses of lavender-colored mica assumed to be lepidolite become prominent (c). Typically such a cavity is mostly lined with quartz, cleavelandite and lepidolite flakes of magnificent quality.

Besides the limited number of large tourmaline crystals deeply rooted in the pegmatite, pockets are, in general, rich in second-generation tourmaline "pencil" crystals, isolated or in large groups and association with other minerals. These crystals are typically of very high gem quality and commonly have antilogous terminations. Specimens show relatively short, second-generation crystals with analogous terminations (usually a pedion face and/or the face of a flat, low-angle trigonal pyramid) and elongated, second-generation crystals with antilogous terminations (characterized by several different crystal forms, including a pedion, and various pyramids).

Pederneira's gem-quality tourmaline is characterized by a wide variety of red, purple, blue, green and yellow colors. Multicolored to bicolored and "watermelon" crystals are common; color zoning can be parallel to the *c* axis, perpendicular to the *c* axis, or parallel to pyramidal termination faces. Blue-green to grayish blue to blue colors are rarer, as is cat's-eye material (red or green). The high-quality gem crystals in the pockets consist largely of second-generation "pencils" with analogous (mostly pedial) terminations or antilogous (mostly pyramidal) terminations. (Pezzotta *et al.*, 2011).

Microprobe analyses of gem-grade tourmaline from the Pederneira mine revealed compositions in the elbaite field, with variable contents of fluorine and a high rossmanite component in some pink samples. Foitite was confined to dark green to black portions of the crystals. The only significant minor elements were iron and manganese. Black schorl occurs in some parts of the pegmatite, and a black tourmaline (probably dravite) occurs in the exocontact zone of the schist adjacent to the pegmatite.

***Table 1.* Minerals found in the Pederneira pegmatites.**

Albite	$NaAlSi_3O_8$
Beryl	$Be_3Al_2Si_6O_{18}$
Tourmaline Group:	
Elbaite	$Na(Al_{1.5}Li_{1.5})Al_6(Si_6O_{18})(BO_3)_3(OH)_3OH$
Rossmanite	$\square(LiAl_2)Al_6(Si_6O_{18})(BO_3)_3(OH)_3OH$
Foitite	$\square(Fe^{2+}_2Al)Al_6(Si_6O_{18})(BO_3)_3(OH)_3OH$
Dravite	$NaMg_3Al_6(Si_6O_{18})(BO_3)_3(OH)_3OH$
Fluorapatite	$Ca_5(PO_4)_3F$
Orthoclase	$KAlSi_3O_8$
Helvine	$Mn_8[Be_6Si_6O_{24}]S_2$
Hydroxylherderite	$CaBe(PO)_4OH$
Mica Group (including Lepidolite)	
Quartz	SiO_2
Spodumene	$LiAlSi_2O_6$

The Pockets!

***Figure 118*. Burkhard's Pocket was found completely collapsed. Tourmaline crystals were beneath the rubble. José Menezes photo.**

SPECIMEN PREPARATION

It is important to note that most new mineral collectors today have never been in a working mine and consequently have never seen their favorite minerals in place; nor do they realize what it takes to get the specimens out and prepared for display. Having seen minerals being mined around the world at mines of all sorts, and very intimately at the Pederneira mine for over a decade now, I have acquired an immense appreciation for what it takes to bring a mineral specimen to market, and for the processes by which minerals themselves form in the earth. When you look at minerals displayed at shows you can hardly comprehend all the forces that had to be in perfect unison to allow those objects to be sitting before you. Their formation in the earth's crust is just the first step in the process of bringing them to collectors; next comes locating them, then extracting them in good condition, then reconstructing them as they grew in nature, then properly cleaning and trimming them in the lab, then finally transporting them to a marketing venue. All along the way there are countless pitfalls that can and do occur before these treasures can go on display in well-lit cabinets to be admired by collectors.

As mentioned above, pockets of tourmaline in the Pederneira mine are almost always found in a collapsed state, with tourmaline crystals broken and scattered about. Repairs are necessary, but such is also the case with the majority of other important tourmaline localities worldwide, and collectors have come to accept this fact. The very long and slender crystals, especially, are easily broken. Explosive decompression during pocket crystallization, tectonic fracturing of the pockets later, infiltration of mud and water into the pockets, the shock from dynamite charges used in mining the hard pegmatite—all of these things can damage pocket crystals, and it is a miracle that any specimens survive at all.

Currently there are four major laboratories in the world that can do the skilled work necessary to finish tourmaline specimens to the level of internationally recognized standards of preparation; two of them are in Colorado, one is in Italy and one is in New Jersey. We have been employing at least three of these labs at all times to clean, trim, repair and restore specimens. Although the pieces of the specimens have already been found and fitted together temporarily by the first team of preparers in Brazil, attaching them permanently and perfectly is a task that requires a great deal of experience, incredible patience and lots of time. A pocket of specimens can easily be in the lab for six months to a year or more during reconstruction.

Once the specimens are all finally prepared, they can be brought to market. They are photographed again, this time for final documentation and for possible publication. A custom base is made

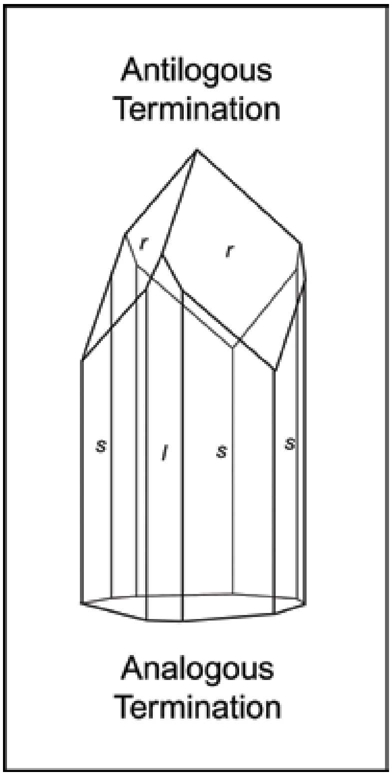


***Figure 119*. Schematic drawing illustrating the two opposing terminations of hemimorphic tourmaline crystals.**

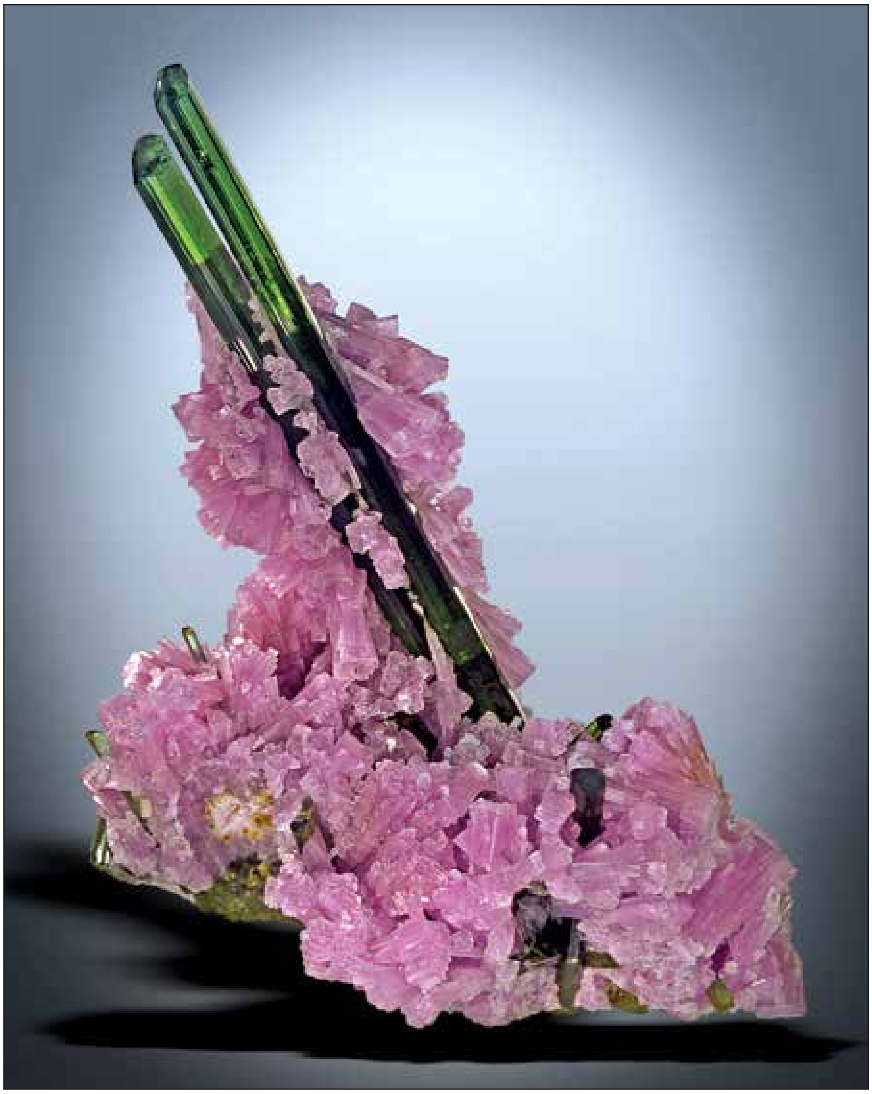


***Figure 120*. Tourmaline crystals with brilliant pink lepidolite, 16 cm, from Keke's Pocket. Marcus Budil specimen; Stuart Wilensky photo.**

specifically for each specimen so as to display it in its most appealing orientation. A label is prepared and the piece is priced for sale. The whole process, from the instant when the jackleg drill leaps to when the first potential customer lays eyes on a specimen, can consume anywhere from six months to three years.

As I said, most collectors can never fully understand what it takes to bring such specimens to the market. Perhaps this article will help give readers a new level of appreciation when next they see a superb specimen of any species for sale. They can marvel not only at the specimen's beauty but also at the incredible lengths people must have gone to in order to get it from the mine to the showcase. In the end, all of these laborious steps have enabled the preservation of some of the most beautiful minerals ever produced by nature. If any of the steps are skipped, or if something goes wrong, these treasures could be lost forever, and some of the world's greatest mineralogical masterpieces might never be known.

The Pockets!

The Pederneira pegmatite has yielded a large number of individual crystal-lined pockets, each of which has proven to have its own characteristics. Many of the pockets have been given names by the miners, and we have assigned some names as well. These names are necessary to facilitate a comprehensible discussion of all of the pockets. In some cases the finest specimens have been assigned nicknames as well, as is typical in the field of world-class mineral collecting.

DADA'S TUNNEL

Keké's Pocket (1999)

Not having handled the specimens from this pocket, I was only able to see them after they were dispersed into collections across the country. The pocket is named after one of the Pederneira mine partners, Saint-Clair Fonseca Jr. (nicknamed "Keké"), and the specimens from it passed to Arizona mineral dealer Wayne Thompson, who brought them to market. Because Wayne dealt primarily with domestic buyers, most of the specimens went to collectors in the U.S.

Keké's Pocket will surely go down in history as one of the all-time finest tourmaline discoveries made anywhere in the world. Unfortunately it was not collected in a controlled way; had it been, the results would have been even more spectacular. What makes this pocket so special is the outstanding combination of chrome-green, gem-quality tourmaline and hot pink lepidolite. Typically in pegmatite pockets of tourmaline, lepidolite is merely a minor associated species and commonly serves as the matrix for other crystals or as a contrasting accent to the other minerals comprising the matrix, such as quartz, feldspar and albite. But in this pocket the lepidolite is so attractively crystallized that it rivals the associated tourmaline in beauty.

Figure 121. **Tourmaline crystals with pink lepidolite, 8.2 cm, from Keke's Pocket. Illustrated in Wayne Thompson's *Ikons* book. Gene and Roz Meieran collection; James Elliott photo.**

Figure 122. **Tourmaline crystal with pink lepidolite, 12.5 cm, from Keke's Pocket. Wayne Sorensen collection; James Elliott photo.**

Figure 123. **Tourmaline crystals, 15 cm, from Keke's Pocket. Stuart Wilensky photo.**

The pocket was small, yielding only a few kilograms of specimens, but what it lacked in size it made up for in the color and transparency of the crystals. Only half a dozen or so specimens were recovered from the lot that Keké purchased. In the photos shown here, taken in Governador Valadares before the specimens were packed for transport to the U.S., several of the best-known specimens that are in collections today can be recognized. They include the specimen that Laura Thompson (Wayne's late wife) chose for herself (Fig. 122), as well as the wonderful double crystal with lepidolite pictured in Wayne's *Ikons* book (Fig. 121), the lovely group in Figure 120 that is owned by dealer/collector Marcus Budil, and two other crystals which were reconnected later and are now in a private collection, and a gemmy triple crystal having just a touch of lepidolite (Fig. 123).

Six years later a pocket yielding very similar specimens (and likewise only a few in number) was discovered. Named the "Lepidolite and Blue—The End of the Line Pocket," it is described later in this section.

Figure 124. **Deep green tourmaline with hot-pink lepidolite crystals, 16 cm, from Keke's Pocket. Scott Rudolph collection; Jeff Scovil photo.**

Figure 125. **Pale citrine quartz crystals ("the Smoke Stacks"), 42 cm, from the Giant Quartz Pocket. José Menezes photo; current owner unknown.**

Figure 126. **Pale citrine quartz crytals, 60 cm, from the Giant Quartz Pocket. Colorado School of Mines collection; José Menezes photo.**

Giant Quartz Pocket (2000)

The Giant Quartz Pocket produced no tourmaline specimens worthy of note. Nevertheless, it did contain some of the finest natural citrine quartz crystals ever found in Brazil. By the time I arrived in Brazil (hot on the trail of the "Sharon Stone" Pocket—see below), the contents of this pocket had already been extracted and sold on the local market. The pocket was lined by very beautiful cleavelandite crystal groups. In this pocket and many others at Pederneira, cleavelandite reaches the highest possible quality, with thick-bladed, sharp, glassy crystals, somewhat translucent and with a little tint of blue. This bluish cleavelandite is the pinnacle for the species, and where it is associated with incredible quartz crystals the combination is outstanding (the only mineral missing is tourmaline)! On my very first trip I was fortunate to have the opportunity to buy the two best pieces from this pocket. Although the price for quartz at that time was reasonable, these two pieces were valued very highly by their owners.

The first specimen, nicknamed the "Smoke Stacks," is a pair of quartz crystals leaning slightly towards one another on a matrix of beautiful cleavelandite, with absolutely beautiful luster and no

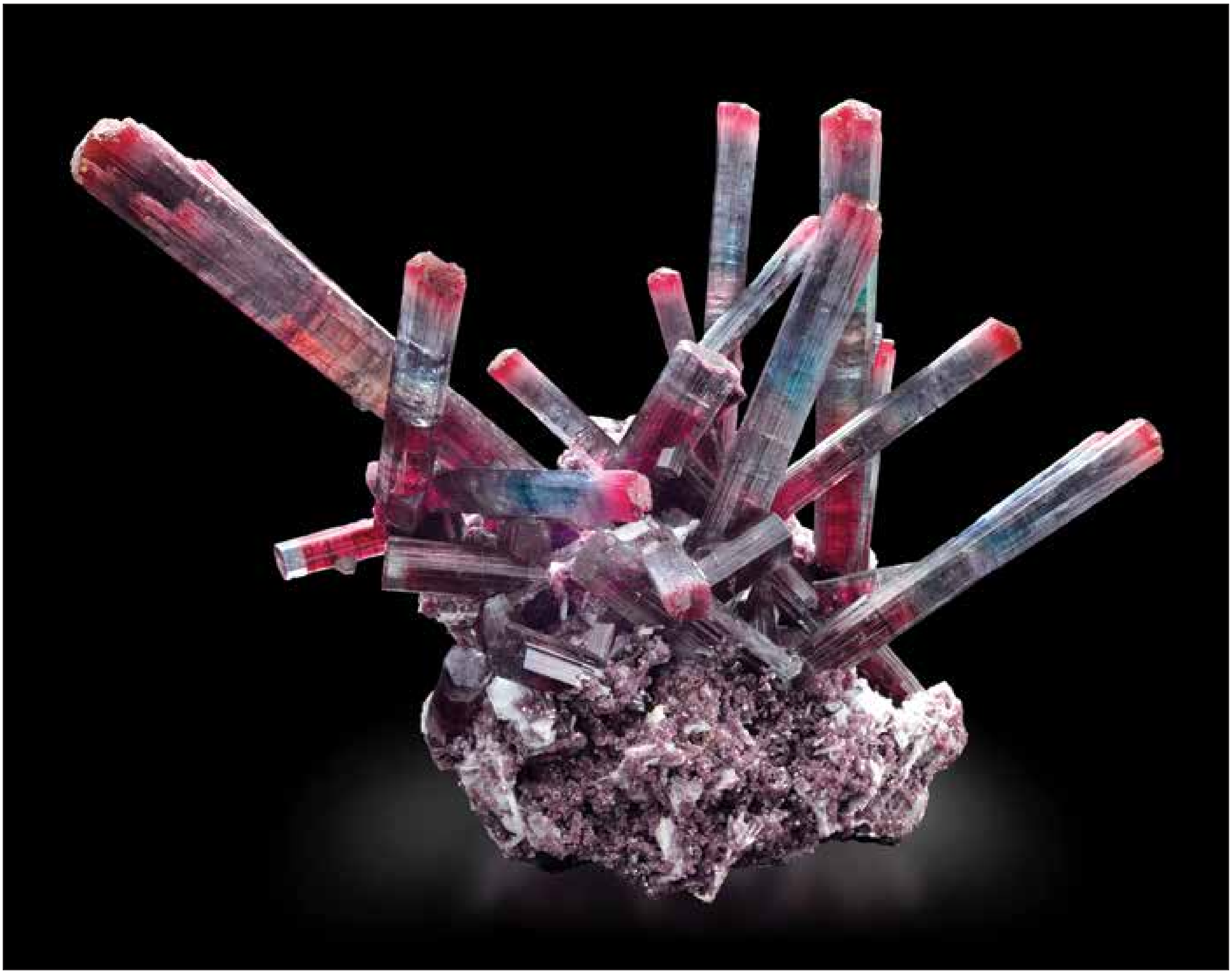


Figure 127. **Tourmaline crystal group ("the Firecracker"), 25 cm, from the Sharon Stone Pocket. Fine Minerals International specimen; James Elliott photo.**

damage—it is perfect! At the time, dealers did not document things the way they do today, nor did we have professional photographers as readily available, so I only have a few snapshots taken on the day when the specimens were acquired. But you can still see the superior quality even in these poor representations. We did not record the exact dimensions either, but we estimate that this one was around 35 cm across and 45 cm tall.

The second specimen from the pocket is the larger of the two, and the quartz is even more impressive than on the first. The quartz crystal sits up at about 30 degrees from a plate of perfect cleavelandite blades. A few other, smaller quartz crystals form what looks like a nest around the largest one, and a few dark green tourmaline crystals to 5 cm in length are growing here and there. The remarkable luster, clarity and perfection of the quartz are rare for such a large crystal. The specimen was sold at the 2001 Denver Show to Colorado mineral collector Bruce Oreck and was later donated to the Colorado School of Mines, where it is currently on display. This specimen is very heavy and large, easily over 40 kg and about 60 cm across; the main quartz crystal is about 50 cm in length!

Sharon Stone Pocket (2000)

The Sharon Stone Pocket was quite large, and produced some lovely tourmaline specimens. At the time of the discovery the American actress Sharon Stone was quite popular in Brazil, and the owners of the mine were so impressed by the great beauty of the principal specimen from the pocket that they decided to dub it "Sharon Stone" (Fig. 2). As previously mentioned, this pocket was acquired by Colorado mineral dealer Bryan Lees and marketed by The Collector's Edge. Consequently my knowledge of the pocket size and the total number of fine specimens it produced is a bit limited. But pictured here is a shot of the pocket wall right after it was collected (Fig. 133), the specimens on the table in Brazil before they were packed up (Fig. 134), and the very image (Fig. 1) that was shown to me by Michel Jactat (and that changed my life forever).

The tourmaline crystals in the pocket are a combination of blue and red. Tourmaline is hemimorphic and, as is common in almost all of the Pederneira pockets, some crystals are terminated by the face of the analogous pole (the flat pedion termination) and others by that of the antilogous pole (usually a steep pyramidal termination but sometimes also with a small negative pedion). In the Sharon Stone Pocket, crystals with the analogous termination have a red core with a blue exterior and a blue cap. Those with an analogous termination have flat, sharp, glassy terminations with the red core running up to the last 2 or 3 cm before the blue cap begins. The crystals with antilogous terminations (the most prevalent habit for all Pederneira tourmalines) begin, like the analogous type, with a red core, and then within the first few centimeters of growth they

Figure 128. **The "Sharon Stone" tourmaline, 17 cm, from the pocket of the same name. James Elliott photo; current owner unknown.**

Figure 129. **Tourmaline crystal group on lepidolite, 25 cm, from the Sharon Stone Pocket. Jose Menezes photo; current owner unknown.**

Figure 130. **Tourmaline crystal cluster, 10 cm, from the Sharon Stone Pocket. Fine Minerals International photo; current owner unknown.**

change to blue, then finally back to red. Crystals with antilogous terminations are typically more slender and elongated and have complex terminations with many facets. Antilogous crystals from this pocket are very easily identified; they look very much like a Chinese calligraphy brush.

The "Sharon Stone" specimen is a wonderful example of the masterpiece-quality specimens that the Pederneira mine is capable of producing. It has wonderful aesthetics, with three main crystals radiating from a central point on a matrix of purple-pink lepidolite crystals. Each of the three tourmaline crystals stands nearly 17 cm tall. The photo shown in Figure 1 is the one that caused me to drop everything and take off for Brazil.

The pocket itself was about 1 cubic meter in volume. It yielded over 50 fine tourmaline specimens, some of which are shown in

Figure 131. **Antilogous termination on a crystal from the Sharon Stone Pocket. Fine Minerals International photo.**

Figure 132. **Tourmaline crystal cluster with lepidolite ("the Scarecrow"), 20 cm, from the Sharon Stone Pocket. Keith Proctor collection; Jeff Scovil photo.**

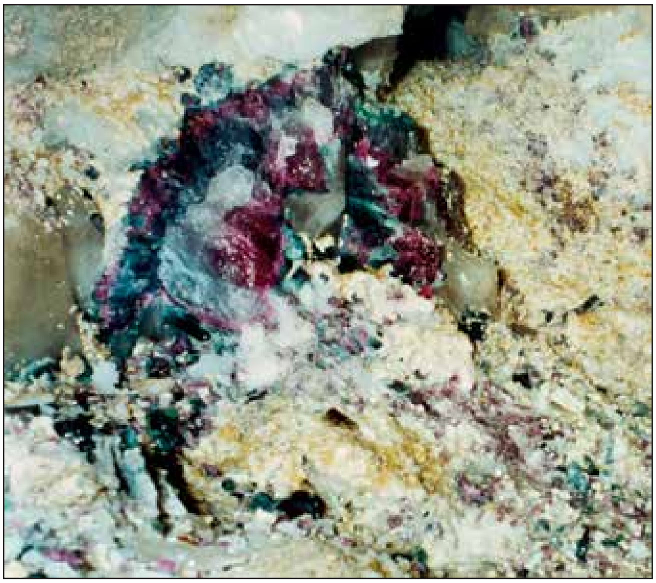


Figure 133. **Pocket wall in the Sharon Stone Pocket showing broken crystal bases where crystals were later reattached. José Menezes photo.**

Figure 134. **Table covered with crystals recovered from the Sharon Stone Pocket (including the "Sharon Stone" specimen itself in the foreground) awaiting reconstruction in the Pederneira office in Governador Valadares. José Menezes photo.**

***Figure 135*. Thiago Menezes looking over the reconstructed specimens from the Sharon Stone Pocket in 2001. José Menezes photo.**

***Figure 136*. Tourmaline crystal group ("the Towers"), 16 cm, from the Sharon Stone Pocket. José Menezes photo; current owner unknown.**

Figure 134. In Figure 135 you can see part of the process for reassembling the pocket specimens.

The matrix from this pocket is typical for the mine: various combinations of feldspar, cleavelandite, quartz and lepidolite. When reuniting crystals with their matrixes, some connection points are obvious but others are very difficult to find; some take days or months to locate, and many are never found at all. No one pocket has ever been put back together in its entirety; if 70% of the pocket can be reassembled, that is considered a huge success.

In addition to the "Sharon Stone" specimen there were other fantastic pieces, the best of which are shown here. One of the finest specimens from the pocket, the "Firecracker," is another world-class example, measuring nearly twice as large as the "Sharon Stone" specimen: nearly 23 cm tall and 25 cm across. It is a beautiful assemblage of colorful crystals. The pocket also produced large crystals with flat terminations and weighing 500 grams or more, all of which were cut into gorgeous rubellite and bi-colored gemstones!

The Proud Pocket (2000)

As I left Brazil with my two new quartz specimens and no tourmalines, I pleaded with the partners of Pederneira to give me a consolation prize, by way of promising me a chance to acquire at least one fine specimen from a future pocket. Happily, they agreed.

Less than a month later—just a few weeks after the Sharon Stone Pocket had been discovered—the miners broke into another significant pocket. They were so proud that their good prospecting instincts had led them in the right direction that they decided to name it "The Proud Pocket." Bryan Lees and Collector's Edge had first option on acquiring the material, and so they bought nearly the entire pocket right away. Consequently I have little personal information about the full breadth of the pocket, but some photos showing a few lovely specimens are included here.

As promised, however, the partners had reserved one great specimen for me, so I jumped on the first plane I could get and flew to Brazil to see it! The partners first showed me some of the specimens from the pocket that Bryan had already purchased, but I forgot all about the rest of the pocket when they showed me the specimen they had reserved for me. It was beautiful! The piece was huge, almost a meter across and nearly 40 cm tall; it was obviously going to need trimming. The main tourmaline crystal alone approaches 14 cm long and 7 cm in diameter, and it projects aesthetically from the side of a quartz crystal with flowers of albite and lepidolite

Figure 137. **Tourmaline crystals on lepidolite, cleavelandite and quartz ("the Giant"), 90 cm, from the Proud Pocket, with Junior Tomich. Private collection; José Menezes photo.**

Figure 138. **Tourmaline crystal group with quartz and lepidolite, 18 cm, from the Proud Pocket. Jeff Scovil photo; current owner unknown.**

***Figure 139*. Tourmaline crystal group with lepidolite and cleavelandite, 28 cm, from the Proud Pocket. Peter Via collection; James Elliott photo.**

***Figure 140*. Detail of the specimen in Figure 139 showing the two styles of terminations. James Elliott photo.**

***Figure 141*. Tourmaline crystal on cleavelandite and lepidolite, 19 cm, from the Proud Pocket. Jeff Scovil photo; current owner unknown.**

Figure 142. **Tourmaline crystal group, 18 cm, from the Proud Pocket. Jeff Scovil photo; current owner unknown.**

Figure 143. **Large tourmaline crystal (14 cm) from "the Giant" specimen, later cut into gemstones. José Menezes photo.**

Figure 144. **V-shaped tourmaline cluster on cleavelandite, 14 cm, from the Proud Pocket. Jeff Scovil photo; current owner unknown.**

surrounding the base. It is truly an awe-inspiring specimen. The quartz crystal originally had another tourmaline growing directly out of its termination, but this had broken away, either in the past or during the excavation process. This crystal was indeed found, but because the Pederneira team at that time had mostly lapidary backgrounds, the high gem value of the crystal was too much to resist: it was cut into gemstones rather than being reattached to the specimen where it belonged.

Within a short time I was able to get the partners to give me a price, and, as I had suspected, it proved to be even higher than what I believed the maximum retail selling price could have been on the current market. Nevertheless I knew that this was a chance of a lifetime. If I wanted to work with this group of men in the future and if I wanted to have future access to the mine I needed to make a deal for this piece somehow. But buying it outright would have used almost all of my available capital, and I would not have been able to make a profit. So I suggested an alternative approach: instead of buying the specimen outright, I offered to quote them the actual current retail value, and if they could agree on a wholesale price less than that value, I would buy a half-interest in the specimen and then bring it to market, and we would all share the final sales price. This idea struck a chord with the group, and over the next few days, after several meals of *picanha* (the finest cut of steak in Brazil) and plenty of draft beer, we ironed out an agreement. It not only covered this one specimen but guaranteed also that my company would be allowed to acquire a 50% stake in *all* future finds. Our respective teams joined forces and we became

Figure 145. **José Menezes sitting beside the Rocket Pocket following removal of the crystals.**

Figure 146. **Tourmaline with quartz, 8 cm, from the Rocket Pocket. Fine Minerals International specimen; James Elliott photo.**

partners. My side was responsible for cleaning, trimming, preparing and offering all of the material to the world market. And so in a week's time I went from being a buyer to being a partner, and I have never looked back!

As in most Pederneira pockets, the matrix in the Proud Pocket was a combination of several well-crystallized minerals including K-feldspar, quartz, cleavelandite and lepidolite. The color of the flat-topped (analogous) tourmaline crystals is a vibrant rubellite red in the center, grading in the last few centimeters to a bluish green color at the termination.

The antilogous crystals are quite different and come in at least two variations. In all cases they begin with a rubellite core that goes up the crystal for the first 3 or 4 centimeters; then the color shifts to a gemmy greenish blue. Finally, in the last 2 cm, a more nearly opaque yellowish green color takes over. These antilogous crystals have, in their two variations, either a flat pedion termination or a face-rich, peaked pyramidal termination. Distinctive features such as these are peculiar to each pocket, and can be used to determine the pocket of origin. The Proud Pocket was the only pocket found in Dada's Tunnel with this particular tourmaline color scheme.

The Rocket Pocket (2001)

The Rocket Pocket was found soon after the Proud Pocket, and was named after three beautiful tourmaline crystals with rocket-like shapes (Figs. 147, 148 and the frontispiece on page 2). My partners called me, saying that I needed to come back to Brazil immediately. I honestly could not believe it. I had seen production reports from other mines, but the frequency and quality of what was being produced at the Pederneira mine was extraordinary. So I took off once again for Governador Valadares and was soon sitting at a table in front of some beautiful, high-quality, gem-green crystals ranging

Figure 147. Scepter tourmaline ("the Missile"), 11 cm, from the Rocket Pocket. Fine Minerals International specimen; James Elliott photo.

Figure 148. Scepter tourmaline ("the Space Shuttle"), 11.6 cm, from the Rocket Pocket. James and Gail Spann collection; Jeff Scovil photo.

in size from 2 cm to about 12 cm. I had never before seen crystals so gemmy-clean and glassy. The best of the three "rocket" crystals is just gorgeous and had me captivated; I probably picked it up and put it down a dozen times in the first hour. The entire pocket was probably only half a cubic meter in volume or slightly larger, but it yielded over 350 crystals. I numbered every crystal with a little sticker and made a log of the sizes and weights. This is definitely one of my favorite pockets from the Pederneira mine.

Tourmalines from the Rocket Pocket show several interesting characteristics. Nearly all of the crystals have antilogous terminations, consisting of a three-faced trigonal pyramid with several small, vicinal faces modifying the tip. The crystals have a red rubellite core, and then, about a third to halfway up, they become a pure, gemmy, green-blue color; then, with a gradual blending effect, they become a solid green with some yellowish tones. The colors are striking!

Another characteristic of rocket-shaped crystals is the result of selective dissolution. Tourmaline, being hemimorphic, does not dissolve equally from both ends; in a corrosive environment it may start dissolving only from one end and burn down like a cigar. Furthermore, some color zones seem to be far more vulnerable to dissolution and corrosion than others. Tourmaline crystals from the Rocket Pocket often show a fibrous, corroded zone separating the red rubellite core from the outer green-blue zone. In some crystals the fibrous zone is very thin, whereas in others it is quite thick, or

Figure 149. **Tourmaline multiple scepter, 10.3 cm, from the Rocket Pocket, Pederneira mine. James Elliott photo; Fine Minerals International specimen.**

Figure 150. **A cluster of three gorgeous tourmaline crystals ("the Take-off"), 12 cm, from the Rocket Pocket. The specimen has only one repair and is recrystallized on the bottom termination. Fine Minerals International specimen; James Elliott photo.**

Figure 151. **The author taking inventory of all of the Rocket Pocket specimens. José Menezes photo.**

***Figure 152*. Tourmaline crystals on cleavelandite, 13.1 cm, from the Rocket Pocket. James Elliott photo; current owner unknown.**

***Figure 153*. Tourmaline crystal on a quartz crystal ("the Mini King"), 4.5 cm, from the Rocket Pocket. Gabriel Risse collection; Malte Sickinger photo.**

***Figure 154*. Tourmaline crystals with cleavelandite, lepidolite and feldspar ("Ignition"), 14.2 cm, from the Rocket Pocket. This is the finest specimen recovered from the pocket. Fine Minerals International specimen; James Elliott photo.**

the outer zone has been dissolved away entirely. In many cases the outer zone has broken off, leaving just the core of the prism topped by the original full-width termination to create a scepter shape. The fragile outer zone may have been broken off when the crystals were broken away from the matrix during the pocket rupture or the chill-shock phase of pocket formation. We sometimes find crystal section rings scattered about the pockets, sometimes reattached in random orientations by subsequent crystallization, or the outer zone might have been broken off as a result of blasting and mining. It may be impossible to tell the difference; in some cases further crystallization has taken place on the broken ridges of the rind as well as on the stem itself.

Tourmaline scepter formation is completely natural: I have found numerous examples in the Rocket Pocket and other isolated instances in other pockets at Pederneira and other mines as well. The rockets and scepters that I have seen from the Pederneira mine all came out of the pockets exactly as they are, without modification. And there is documented proof of the specimens which dates to the time of their discovery.

Caveats remain, though. In a few cases the termination of a scepter has become completely detached from the stem, and fakes from other mines are known in which a termination has been attached to the wrong stem. Scepters should be carefully examined to make sure that the stem fits perfectly into the termination.

The selective corrosion not only resulted in the rocket shapes but also limited the preparers' ability to reunite crystals with their original positions on matrix. Consequently there are very few matrix specimens from the Rocket Pocket, but those few that exist are of outstanding quality. In all pockets at the Pederneira mine the matrix is composed mostly of crystals of the same simple suite

Figure 155. **Tourmaline crystals penetrating a large morganite crystal, 14 cm, from the Rocket Pocket. This is one of the few fine morganite crystals recovered from Pederneira. Rob Lavinsky (*The Arkenstone*) specimen; Joe Budd photo.**

Figure 156. **The author in 2014 showing where the Afghan Pocket had been found. Alexis Talbot photo.**

of minerals, but in the Rocket Pocket the quality of those crystals is extraordinary. The quartz crystals are nearly flawless and have brilliant luster. The cleavelandites occur in snow-white, rose-like shapes, and there are small purple lepidolite crystal stacks speckled here and there. The combination is the perfect backdrop for gem tourmaline crystals. There is even one specimen of morganite beryl from the pocket that has been pierced through by green tourmaline crystals. This is one of only a small handful of morganite crystals known from the Pederneira mine.

The Afghan Pocket (2001)

Whoever said "great things come in small packages" must have been familiar with the pockets at Pederneira. Shortly after the Rocket Pocket was found another amazing pocket was encountered. It was a small pocket which yielded only about a dozen specimens. But what incredible specimens they were! (See especially Fig. 28!)

The colors of the tourmalines in this pocket are distinctly different from those in any other pocket collected at the Pederneira mine. They are more reminiscent of the vibrant pastel colors of tourmalines from the Dara-i-Pech pegmatite field in Afghanistan, hence the pocket's name: the Afghan Pocket.

The matrix from this pocket is lovely as well. The whole pocket was no larger than a small beach ball. The tourmaline crystals from the pocket have both kinds of terminations. The ones showing the antilogous habit have pyramidal terminations of slightly lower angle than those in the Rocket Pocket. The distinguishing trait of tourmaline from this pocket is a colorless, transparent zone through the crystals just a few centimeters down from the pyramidal terminations.

***Figure 157*. Tourmaline crystals (some sceptered) on quartz ("Afghan Steel"), 12 cm, from the Afghan Pocket. Marcus Budil specimen; Malte Sickinger photo.**

***Figure 158*. Tourmaline crystal with lepidolite, 7 cm, from the Afghan Pocket. Gabriel Risse collection; Malte Sickinger photo.**

***Figure 159*. Tourmaline on cleavelandite, 11.5 cm, from the Afghan Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 160*. Tourmaline on cleavelandite, 13.5 cm, from the Afghan Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 161. **Tourmaline crystals with cleavelandite, 14 cm, from the Afghan Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 162. **Tourmaline crystals on cleavelandite and lepidolite, 18 cm, from the Afghan Pocket. Fine Minerals International specimen, James Elliott photo; current owner unknown.**

Figure 163. **Tourmaline crystals on quartz, 17 cm, from the Afghan Pocket. This specimen has been nicknamed "Gêmeos" (Portuguese for "the Twins"). Fine Minerals International specimen, James Elliott photo; current owner unknown.**

Figure 164. **Tourmaline crystals on quartz, 14 cm, from the Afghan Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

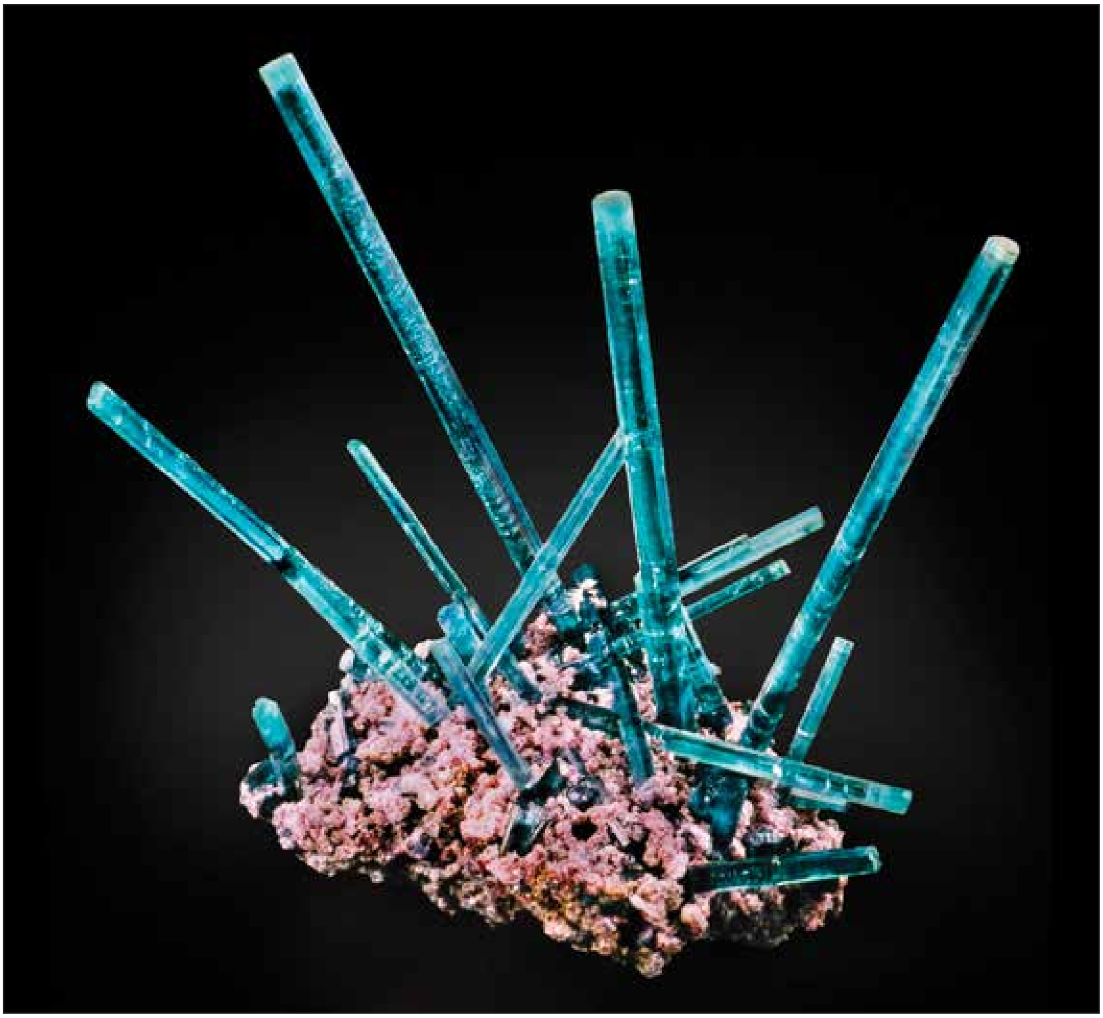


Figure 165. **Tourmaline crystals on lepidolite ("the Porcupine"), 37 cm, from the Porcupine Pocket. Smithsonian Instutution collection, now on display; Jeff Scovil photo.**

The Porcupine Pocket (2001)

To call 2001 a banner year at the Pederneira mine would be an understatement of epic proportions. During that year the mine produced an almost incomprehensible amount of diverse, high-quality material in a very short time. But much more was still to come, and none of us (partners, miners, collectors and owners) really understood the significance of what was happening because it was all happening so fast.

The next major pocket to be discovered was the Porcupine Pocket, a very large pocket, likely the largest up to that time in the production history of Dada's Tunnel. Again it yielded a new tourmaline crystal habit, with crystals of a steely blue color. The longest (antilogous) crystals are up to 35 cm in length and 2 cm thick. As is often the case in tourmaline pockets, many of the crystals were broken into several sections and required multiple repairs. Some crystals needed over 10 repairs, while others have none at all. The unbroken ones survived by some miracle, like the specimen in Figure 171, which is a total floater (with not a single repair), dubbed "Legs."

Production coming from the Porcupine Pocket required that the reconstruction process being carried out by our team in Brazil had to be expanded and perfected. Reassembling the crystals and reattaching them to their proper places on matrix was no longer the work of one or two people for a week or so. So we hired staff whose sole task was to solve these puzzles. The pocket contents were kept in a special room where they were laid out and organized by similarities, color tones, size, crystal diameter, associations, and any other features that could provide correlations between any two pieces. Seen here (Figure 167) is one of our team members, who spent his days assembling puzzles. In the photo you can see (in the background on the left) a large lepidolite crystal matrix with little white stickers that is the actual matrix that forms the base of the specimen nicknamed "The Porcupine" (giving the pocket its name). This system became our standard practice for every pocket subsequently discovered, and it is still being used at the mine today.

Reconstructing a single large specimen can easily take several months to half a year. And that's just the beginning of the process. Then, following negotiations between the partners, the specimens are disassembled, packed and transported to the United States, where they receive a final cleaning, are reassembled and undergo any needed repair and restoration. Then they are mounted on Lucite bases, labeled, photographed, priced, and finally presented to potential buyers. The whole process of bringing a single pocket to collectors can easily take a year or more. In the case of especially large pockets the process can take several years.

The Porcupine Pocket ultimately yielded several extraordinary specimens including the ones nicknamed "The Porcupine," "The Sailboat," "The Blue Star," "Legs," "The Hat," and dozens of others. Some of them are shown here.

Figure 166. **Tourmaline crystals on lepidolite with quartz and cleavelandite ("the Sailboat"), 61 cm, from the Porcupine Pocket. This is the largest crystal group recovered from the pocket. Chris Burch collection; James Elliott photo.**

Figure 167. **Specimens from the Porcupine Pocket awaiting reassembly. José Menezes photo.**

Figure 168. **Tourmaline crystal cluster, 16 cm, from the Porcupine Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 169. **Tourmaline crystals on a small piece of matrix, 33 cm, from the Porcupine Pocket. Marco Tironi collection; James Elliott photo.**

Figure 170. **Tourmaline crystal group ("the Blue Star"), 24.6 cm, from the Porcupine Pocket. James Horner collection; Jeff Scovil photo.**

Figure 171. **Tourmaline crystal spray ("Legs"), 20 cm, from the Porcupine Pocket. The specimen is a "floater" showing no obvious point of attachment to matrix. Mim Museum collection, Beirut; James Elliott photo.**

Figure 172. **Tourmaline crystal with quartz crystal, 19 cm, unrepaired, from the Porcupine Pocket. Stuart Wilensky photo; current owner unknown.**

Figure 173. **Tourmaline crystal group, 12 cm, from the Porcupine Pocket. Jeffrey Collins collection; Jeff Scovil photo.**

Figure 174. **Tourmaline crystals with quartz, 10 cm (unrepaired) from the Porcupine Pocket. Peter Via collection; James Elliott photo.**

Figure 175. **Tourmaline crystal (doubly terminated) on a quartz crystal, 13 cm, from the Porcupine Pocket. Peter Via collection; James Elliott photo.**

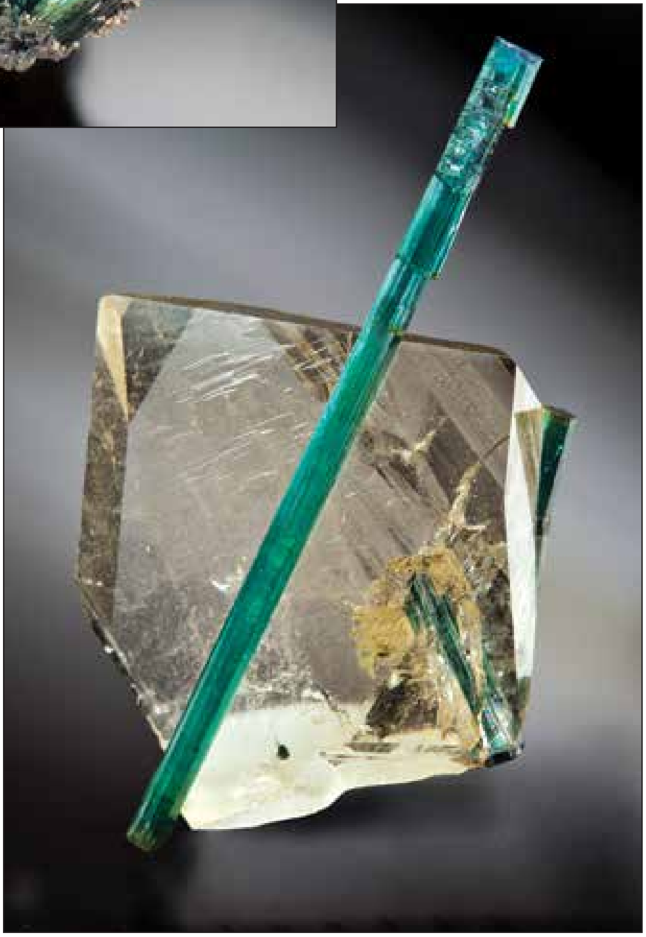


Figure 176. **Tourmaline crystals with quartz ("the hat"), 17.7 cm, from the Porcupine Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 177. **Tourmaline crystals on quartz, 17 cm, from the 18% Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

The 18% Pocket (2002)

Kicking off 2002 was the discovery of yet another very special pocket at the Pederneira mine. The 18% Pocket was named for the percentage I was limited to purchasing—the result of a peculiar situation between the partners in dealing with debts among some of them. I was still pleased to be able to handle the material, and

Figure 178. **Crystals from the 18% Pocket laid out for sorting and reassembly. José Menezes photo.**

Figure 179. **Tourmaline crystals on a small piece of matrix ("Double-V"), 22 cm, from the 18% Pocket. Scott Rudolph collection; James Elliott photo.**

I continued, as usual, buying shares and bringing the specimens to market.

The pocket was not very large but the specimen quality is very high. Crystals reach 20 cm long and over 2.5 cm in diameter, with large gem-quality sections. Some of the partners were eager to cut some outrageous gems from the crystals, but fortunately cooler heads prevailed and all of the best specimens were preserved uncut. Despite the middling size of the cavity, it yielded very few specimens; most of the pocket contained loose crystals with no matrix or broken crystals that we could not reunite with matrix. In the end, all of the pieces were reconstructed into only six major specimens, all shown here.

What makes the specimens from this pocket so lovely are the huge flawless sections in all of the major crystals. Nearly 45% of the volume of the crystals is flawless gem-grade tourmaline, and the color is a vibrant blue. In the antilogous crystals there is a reddish pink color zone in the last centimeter of the termination, capped by a flat pedion face with one dominant bevel only. No other pocket at Pederneira produced crystals with this trait.

***Figure 180*. Tourmaline crystals on cleavelandite, 16.5 cm, from the 18% Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 181*. Tourmaline crystals with lepidolite and quartz ("Chopsticks"), 24 cm, from the 18% Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 182. **Tourmaline crystals on lepidolite, 33 cm, from the 18% Pocket. This is the largest single crystal recovered from the pocket. Fine Minerals International specimen; Federico Picciani photo.**

Figure 183. **Tourmaline crystals on quartz with lepidolite, 28 cm, from the 18% Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

The Morganite Pocket (2002)

The Morganite Pocket was a small vug that produced only a limited amount of specimen material. The tourmaline found there is very similar to that of the Rocket Pocket, with the same fibrous layer of tourmaline between the red core and the outer skin, and with nearly identical terminations on the antilogous crystals. The feature distinguishing tourmalines from the two pockets is the coloration of the tips of the terminations. These tips are yellowish green in crystals from the Rocket Pocket, whereas in those from the Morganite Pocket the corresponding color is a more distinct greenish yellow, and in the final millimeters it is yellow. Once you see one of these crystals you can easily distinguish it from tourmaline from all other, similar pockets.

The namesake of the pocket is a single morganite crystal 7.5 cm in diameter and 6 cm thick. It has an outer rind that is peach-pink. Protruding through the center of the top face of the morganite crystal is a small tourmaline crystal with a flat, lustrous, analogous termination and a lovely green color. Unfortunately I have no photos of the few other tourmalines that were produced from the pocket. The morganite went to my former partner, Marcus Budil, when we divided our businesses, and he then sold it to Bill Larson, in whose collection it resides today.

The Big Blue Pocket (2002)

The next pocket we found was large and small at the same time: large because its volume, over 1.5 cubic meters, was significant, but small because the whole pocket yielded only four specimens. But WOW, what specimens! Three of the four tourmalines have analogous terminations and one has an antilogous termination. The usual quantities of slender antilogous crystals present in most pockets were lacking here. And the single antilogous crystal is so different from the other three crystals that it took a few hours for the partners to convince me that the piece was actually from the same pocket! Like its analogous brethren it is large, 31 cm tall and nearly 5 cm in diameter, and it has a reddish pink body and a green terminal zone a few centimeters thick. It is a great tourmaline and totally unique for the pocket and the mine in general; I cannot think of a comparable example from another pocket.

The specimens with analogous terminations in this pocket set a standard for the habit from Pederneira which has still not been surpassed. The sharpness and luster are so perfect that the faces seem to have been cut by a faceting machine. Specimens nicknamed "Big Blue" and "the Wave" are clearly the two stand-out examples from the pocket. A third specimen, "The Mini Blue," is "mini" only in comparison to "Big Blue" and "the Wave": the tourmaline

***Figure 184*. Tourmaline crystals penetrating a large morganite crystal, 7.5 cm, from the Morganite Pocket. This is the most significant specimen recovered from the pocket. Bill Larson collection; Mia Dixon photo.**

crystal measures about 12 cm tall and 7 cm in diameter and is set on a small plate of white cleavelandite. All three specimens were recovered unbroken (amazingly), and have a deep, rich blue color that varies in saturation from the bottom to the top, shifting back and forth between pure blue and blue-green. Sadly, we never took a photo of the Mini Blue, and its whereabouts today remain unknown.

Each of the crystals is large, but "the Wave" is the biggest, the blocky crystal itself measuring 19 cm tall, nearly as deep, and 14 cm wide. It is perfectly perched atop a beautiful knob of cleavelandite blades, with pink lepidolite crystals forming a huge plume at the base of the crystal and growing in little clusters here and there on the white albite. The piece is topped off with a lovely citrine quartz crystal for good measure. It is nicknamed "the Wave" because on the back part of the top face of the crystal is a late generation of tourmaline growth that covers only part of the termination, where it rises up like a wave. That overgrowth, unlike the rest of the crystal, is a gemmy purple color! This hue is nearly impossible to capture in a photograph, but in person it is very distinctive and adds a great flare to an already incredible specimen.

"Big Blue" is simply a masterpiece of a mineral specimen. The aesthetic position of the two crystals on the matrix, coupled with the perfection typical of the finest quality miniature, is something extraordinary. The termination is glassy smooth without a single defect, disturbance or ripple. Like its big brother, "the Wave," it is also on a knob of cleavelandite roses with beautiful plumes of pink lepidolite at its base and a small embedded citrine crystal. The whole specimen stands 35 cm tall, just slightly smaller than "the Wave," and its main tourmaline crystal measures 11.5 cm tall and 8.5 × 12 cm across.

Figure 185. **Large tourmaline crystal (19 cm) with lepidolite, cleavelandite and quartz ("the Wave"), 38 cm, from the Big Blue Pocket. This is one of two premier specimens recovered from the pocket. Fine Minerals International specimen; Federico Picciani photo.**

Figure 186. **Tourmaline crystal on cleavelandite with mica, 31 cm, from the Big Blue Pocket. The color and habit are very unusual for the pocket. Rob Lavinsky (*The Arkenstone*) specimen; Joe Budd photo.**

Figure 187. **Blue tourmaline crystals on lepidolite, cleavelandite and quartz ("Big Blue"), 35 cm, from the Big Blue Pocket. The main crystal measures 11.5 cm. Peter Via collection; Jeff Scovil photo.**

Figure 188. **Tourmaline crystals with quartz and cleavelandite ("the Grandon"), 75 cm, from the Grandon Pocket. This is the largest single specimen recovered from the Pederneira mine. Houston Museum of Nature and Science collection; James Elliott photo.**

The Grandon Pocket (2004)

The Grandon Pocket was discovered in early 2004 under ideal circumstances at the Pederneira mine. It was not blown into with dynamite, and a round did not go off so close to it as to shake everything to pieces. The presence of the pocket was suspected early, so the miners worked toward it carefully, using the diamond chain saw and the Darda pneumatic rock splitter. This caution did not prevent collapse of the pocket or the need to repair some crystals, but it did result in a 90% reduction in needed repairs.

This improved level of preservation was the result of several factors, including (1) a change in the attitude of the partners, who realized that the mine is really a specimen mine first, and gem rough mine second, with the value of the uncut specimens exceeding that of the cutting rough they could yield; and (2) the skill the miners were developing in the use of the diamond chain saw and pneumatic rock splitter. The implementation of the splitter and the careful collection of the pockets is attributable primarily to José Menezes, who personally collected or guided the collection of every pocket from 2002 until 2006, when the last one was found in Dada's Tunnel.

José's main collecting partner was Junior Tomich, who assisted as his right-hand man during the collection of most of the pockets. Junior is also in charge of the reconstruction process, and his skill

***Figure 189*. A visitor sitting inside the Grandon Pocket. José Menezes Photo.**

***Figure 190.* The Grandon specimen shortly after removal from the pocket, with broken crystal bases marked where crystals will be reattached. José Menezes photo.**

***Figure 191*. A view into the Grandon Pocket shortly after it was breached, looking "down" at the top of the Grandon specimen.**

at reassembling pockets is highly developed. Without Junior's hard work, many of the wonderful specimens known from the Pederneira mine would not be as fine as they are.

The Grandon Pocket was quite large, measuring over 2 cubic meters. The characteristic features of its tourmaline crystals are very subtle. Specimens from the Grandon Pocket are very similar to specimens from the Rocket Pocket, and most people would be hard pressed to tell the difference between the two; even I sometimes have difficulty. The difference is that the fibrous or corroded layer between the red core in the lower parts of the crystals and the outer green zone of the crystals is nearly solid in all crystals from this pocket, but highly fibrous to virtually missing in Rocket Pocket crystals. Consequently the Grandon Pocket has yielded no scepters and no rocket shapes. Furthermore, the areas just below the terminations on crystals with antilogous terminations are slightly darker and sometimes more included. Otherwise, specimens from the two pockets are nearly indistinguishable. Fortunately, by the time the Grandon Pocket was found my team had become more diligent about the documentation of pockets, and they kept good track of all pieces which came from the Grandon Pocket.

***Figure 192*. Tourmaline crystals on quartz, 20.5 cm, from the Grandon Pocket. Keith Proctor collection; James Elliott photo.**

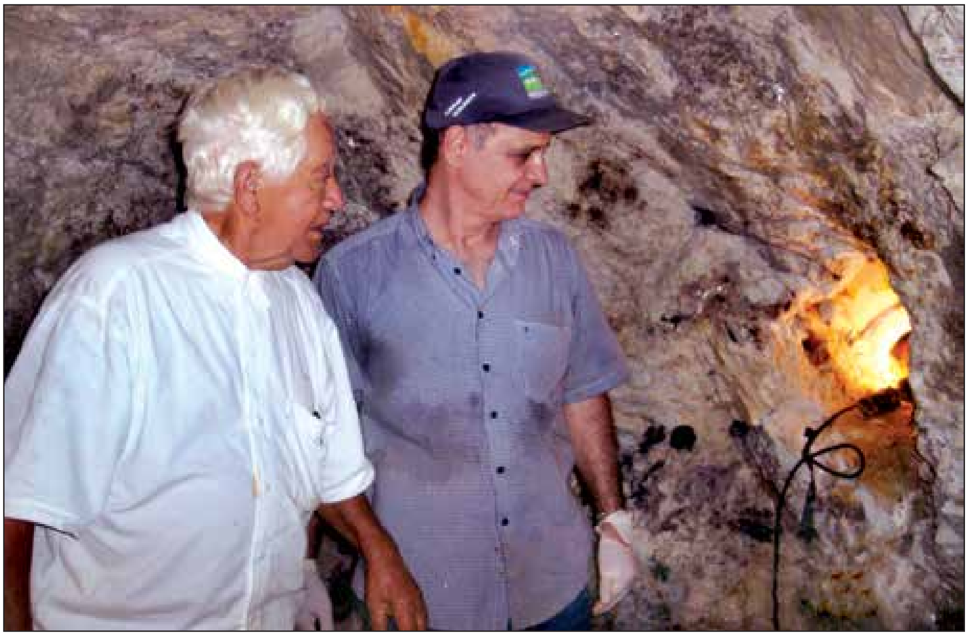


***Figure 193*. José de Oliviera Rocha (nicknamed "Deca") with José Menezes looking into the Grandon Pocket shortly after it was breached.**

A big difference between the yield of this pocket and that of the Rocket Pocket is the maximum size of the crystals. The longest crystals from the Rocket Pocket are about 12 cm whereas for the Grandon Pocket the maximum crystal size is over 30 cm.

The pocket takes its name from the largest intact specimen ever collected at the Pederneira mine. Nicknamed "Grandon," which loosely translates as "the Big Boss," it is one of the marvels of the mineral world. When encountered in the pocket it was lying on its side, so that if you were looking horizontally into the pocket you were looking "down" at the tops of the three giant citrine quartz crystals that comprise the foundation of the specimen. Figure 191 shows just such a view into the pocket, before the specimen was

Figure 194. **Tourmaline crystals with lepidolite and cleavelandite, 45 cm, from the Grandon Pocket. This is the longest single crystal recovered from the pocket. Lyda Hill collection; James Elliott photo.**

Figure 195. (above) **Tourmaline crystals with cleavelandite, 19 cm, from the Grandon Pocket. Matt Zukowski collection; James Elliott photo.**

Figure 196. (above left) **Tourmaline crystals on lepidolite with cleavelandite, 23.7 cm, from the Grandon Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

Figure 197. **Tourmaline crystals on cleavelandite with quartz ("the Pederneira V"), 15 cm, from the Grandon Pocket. James Elliott photo; current owner unknown.**

extracted. The main man responsible for its preservation was José Menezes, shown in Figure 193 standing in front of the pocket with mine owner "Deca," staring into the beauty within. It took over two weeks to collect the specimen and get it out in one huge piece. But that was just the first step in bringing it to life. After it was extracted it had to be transported to the house in Governador Valadares to begin the cleaning and reconstruction process. It took nearly six months to find all of the tourmaline crystals and to correctly reassemble the specimen in all its original beauty. In Figure 190 you can see the specimen after all the crystals' locations had been determined and marked with small stickers. Each spot is the original location where a loose tourmaline crystal has a lock-fit connection to where it once grew. From here the specimen was disassembled again, packed, and

***Figure 198*. Tourmaline crystal cluster, 17 cm, from the Grandon Pocket. Marcus Budil specimen; painting by Eberhard Equit.**

***Figure 199*. Tourmaline crystals to over 20 cm on cleavelandite, from the Grandon Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

***Figure 200.* Tourmaline crystal group with cleavelandite, 32.5 cm, from the Grandon Pocket. Marcus Budil specimen; Malte Sickinger photo.**

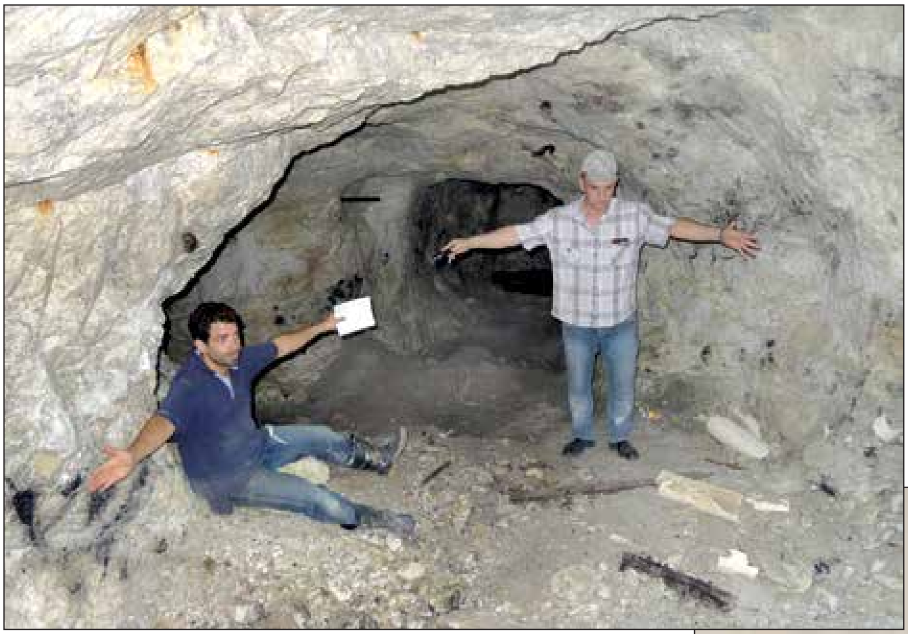


Figure 201. **The author with José Menezes in Dada's Tunnel showing how large the Azul Bien Grande Pocket was. Chris Vaughn photo.**

Figure 202. **Tourmaline and lepidolite specimens from the Azul Bien Grande Pocket, after almost a year of reconstruction. José Menezes photo.**

transported to the United States so it could be carefully trimmed, cleaned, repaired and restored to its original beauty by the professional technicians at the Mile High Mineral Cleaning Lab LLC in Aurora, Colorado. The final result is nothing less than breathtaking. The specimen was finally shared with the world in 2007 at the Tucson Gem and Mineral Show. It has since been sold to a private collector who then donated it to the Houston Museum of Nature and Science, where it is today.

Several other specimens were recovered during the excavation of the Grandon Pocket, and beautiful photos of those pieces fill the pages here. As with specimens from the Rocket Pocket, the matrix for these beautiful green tourmalines is composed of the finest quality cleavelandite, lepidolite and citrine quartz crystals. It is clearly one of the most significant pockets, for both quantity and quality, in the history of the mine.

Figure 203. **Tourmaline crystals with hydroxylherderite and lepidolite, 6.4 cm, from the Azul Bien Grande Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

The Azul Bien Grande Pocket (2004)

As if a pocket the size of the Grandon Pocket was not quite enough, the mine in all its generosity decided to produce a pocket that trumped all those before it in size. The Azul Bien Grande Pocket was discovered in the last days of May, 2004. The direct translation is "Blue, Good 'n' Big," and that is exactly what this pocket was, good and BIG—nearly 5 cubic meters. It seemed as though the tourmaline crystals inside just kept multiplying as they were being removed.

Over three rooms in the Pederneira house in Governador Valadares were required just to lay out all of the pocket contents. It took more than a year of work reconstructing this pocket just to get a handle on the full magnitude of what had been collected. When the first crystal groups were finally completed the results were impressive!

The most amazing specimen from this pocket is a group of crystals averaging 20 to 25 cm long that appears to shoot out in all direc-

***Figure 204.* Pale citrine quartz crystals with minor tourmaline and cleavelandite, 25 cm, from the Azul Bien Grande Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

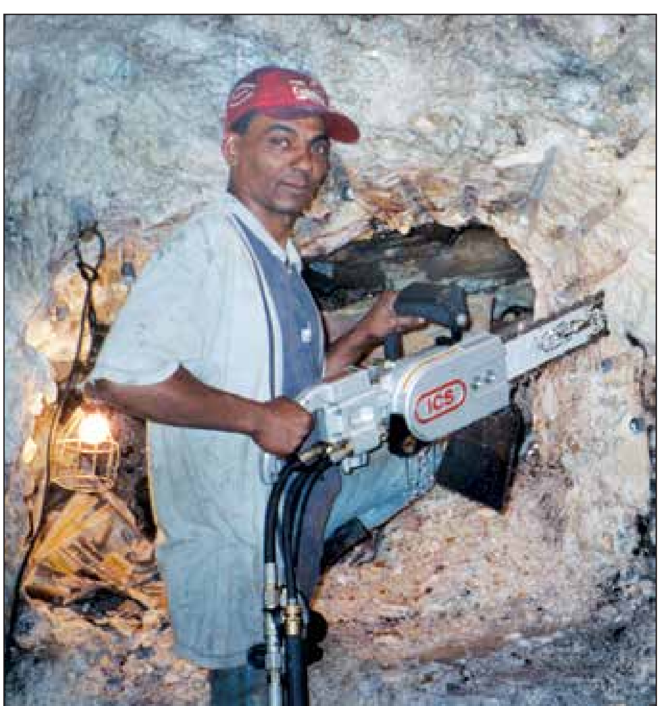


***Figure 205.* Preparing to cut away the pocket walls using the diamond chain saw. José Menezes photo.**

***Figure 206*. Tourmaline crystal with hydroxylherderite crystals, 8 cm, from the Azul Bien Grande Pocket. Marcus Budil specimen; Malte Sickinger photo.**

tions from a cleavelandite and lepidolite matrix, with a stunning three-crystal group rising from the center and climbing straight up perpendicular to the matrix to a height of over 40 cm (Fig. 209).

Another incredible specimen is "the "Smoke Stacks." It is a striking display of both analogous and antilogous tourmaline crystals of a deep blue color, all grown atop blooms of white cleavelandite with citrine quartz crystals and lepidolite. The specimen is 30 cm tall, and each of the massive tourmalines that comprise the "stacks" is 10 cm tall and 9 cm across (Fig. 211).

The pocket produced some of the most elegant specimens ever to come from the Pederneira mine. And, in contrast to the crystals from the Porcupine Pocket, many of which have five, six, or even as many as 15 repairs, several of the longer crystals from the Azul

Figure 207. **José Menezes gathering loose crystals inside the Azul Bien Grande Pocket in May 2004.**

Figure 208. **Tourmaline crystals with lepidolite and cleavelandite, 59 cm, from the Azul Bien Grande Pocket. The 40-cm crystals are the largest recovered from the pocket. Lyda Hill collection; James Elliott photo.**

Figure 209. **Tourmaline crystals with quartz, cleavelandite and lepidolite, 62 cm, from the Azul Bien Grande Pocket. Rob Lavinsky (*The Arkenstone*) specimen; Joe Budd photo.**

Figure 210. (above) **Tourmaline crystals on lepidolite, 28.1 cm, from the Azul Bien Grande Pocket. Fine Minerals International specimen; Federico Picciani photo.**

Figure 211. (above left) **Tourmaline crystals on cleavelandite and quartz ("the Smokestacks"), 30 cm, from the Azul Bien Grande Pocket. Mark Pospisil collection; Joe Budd photo.**

Figure 212. **"The Smokestacks" in the preparation room following reassembly.**

Bien Grande Pocket have just one or two repairs, many just at the bases where the crystals connect with the matrix.

The contents of the Azul Bien Grande Pocket were divided into several portions and marketed over several years. This was necessary for several reasons, but mainly because at that time there was simply too much material for the collector market to absorb in one release. Many specimens took a great deal of time to reconstruct. A final group from this pocket has still not been released; it has been in a lab in Italy for over two years now, and should finally be ready for sale sometime soon. That's over a decade after it was first pulled from the mine! Pictured here are some of the most important specimens from the pocket.

Figure 213. **Tourmaline crystals on quartz, 30 cm, from the Azul Bien Grande Pocket. Chris Douglas collection; Joe Budd photo.**

Figure 214. **Tourmaline crystals with lepidolite and cleavelandite, 21 cm, from the Azul Bien Grande Pocket. Fine Minerals International specimen; James Elliott photo.**

The Bi-Color Steel Pocket (2004)

With the discovery of the Bi-Color Steel Pocket in 2004, the Pederneira mine specimens reached a new level in quality and aesthetics achieved by few mines in history. Just on the heels of the discovery of the enormous Azul Bien Grande Pocket, the miners followed the same mineralized vein and broke into the finest pocket yet discovered. It was not large at all, producing only half a dozen specimens, along with some single crystals. But for the most part this pocket is all about one specimen, the one for which it is named: "Bi-Color Steel" (Fig. 217).

The tourmalines in this pocket are unique: to date nothing similar has been found in any other pocket. The distinctive trait here is evident in the crystals with antilogous terminations. These crystals begin as solid red rubellites, continuing that way halfway up their length, at which point the red color yields to a totally colorless zone for just a few millimeters, followed by a vibrant green zone for a few millimeters, then a vivid, gemmy blue which prevails nearly to the termination. The final color zone at the termination is green with a slight yellow tint. These unique crystals can be recognized at a glance.

The "bi-color" naming (of the pocket and the specimen) is for the two dominant colors seen in the crystals. "Steel" is a word we decided to use to designate any single specimen as being the best of its type, hence Bi-Color Steel. Once you see this specimen you will never forget it. Amazingly, the three main crystals on the piece have just one repair each: two of them directly at the base contacting the feldspar and the other midway through the crystal. Because the pocket was found as a stringer extending from the Azul Bien Grande Pocket, the miners approached it very carefully and collected the contents without causing any new breaks. The condition of the specimens when they came out was extraordinarily good. Apparently the stars and moon were all in alignment that day, so that the finest pocket yet found was discovered in an undisturbed state.

Once they were collected it was evident that the quality and colors of these crystals were unlike anything ever seen before, but it was not until the reconstruction process was nearing completion that the team was able to recognize the true significance of what had been discovered. As the crystals were reunited with their matrix, the specimen began to take shape as it had grown in nature.

The colors, the aesthetic balance, and the beautiful contrasting matrix all add to the incredible impact and charm of this specimen; it is clearly the finest tourmaline yet recovered from the Pederneira mine, and one of the greatest tourmalines (as well as one of the greatest mineral specimens) the world has ever seen.

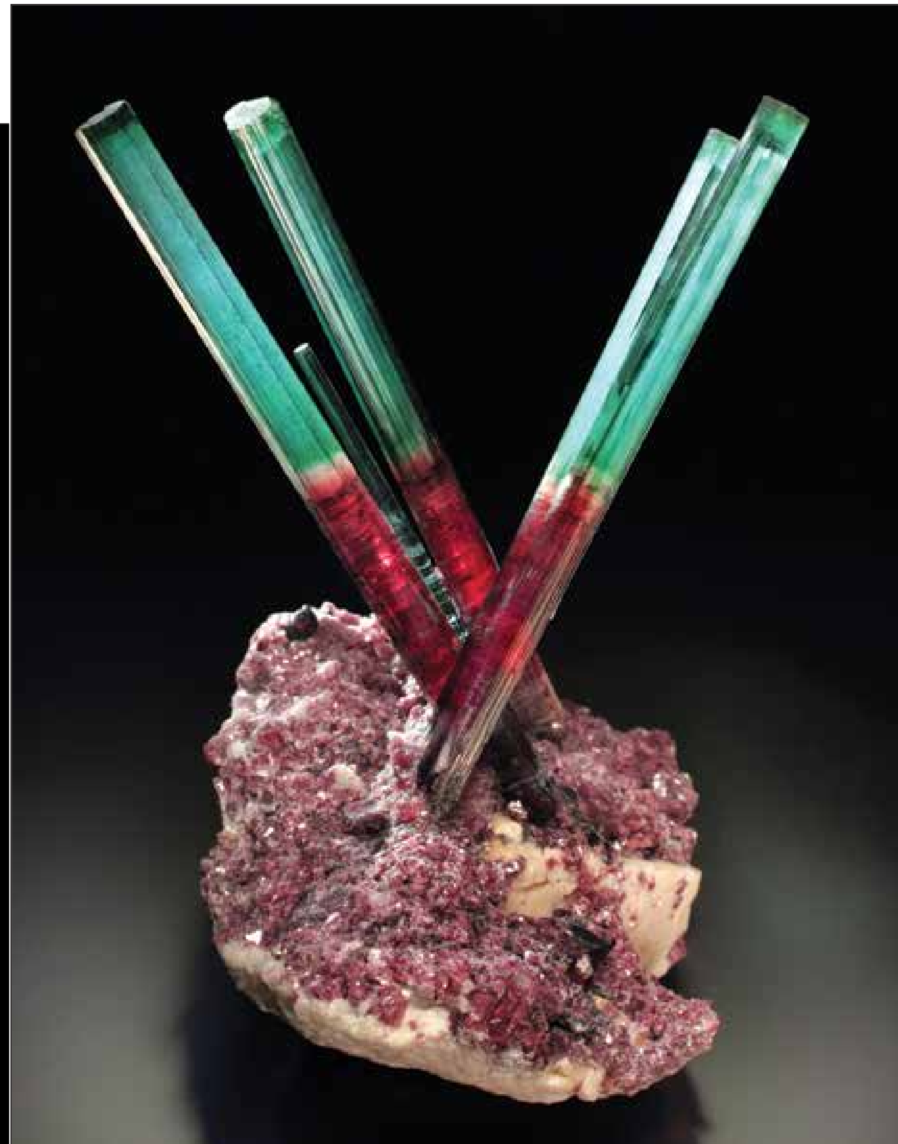


Figure 215. **Tourmaline crystals on lepidolite and cleavelandite ("the Bi-color Star"), 19 cm, from the Bi-color Steel Pocket. Fine Minerals International specimen; Malte Sickinger photo.**

And this was not the only beautiful gift the pocket gave up; another highly important specimen which emerged has been named the "Bi-Color Star." It has the same crystal quality as the "Bi-Color Steel" specimen, and lovely aesthetics as well, with crystals growing on deep red and purple lepidolite.

A third wonderful specimen from the pocket is a small spray of crystals growing on the end of a large feldspar crystal section that was originally attached to the matrix of the "Bi-Color Steel" specimen, but too far away to make it worthwhile to keep the two specimens as one. So a good trimming job created a small cabinet specimen with a burst of vibrant red tourmalines with flat, blue-green terminations and no repairs.

Of the other three specimens, one tourmaline crystal is doubly terminated and has a small quartz crystal attached, while the other two consist of gemmy tourmaline crystals growing on small matrix pieces, one on quartz and the other on a small lepidolite cluster.

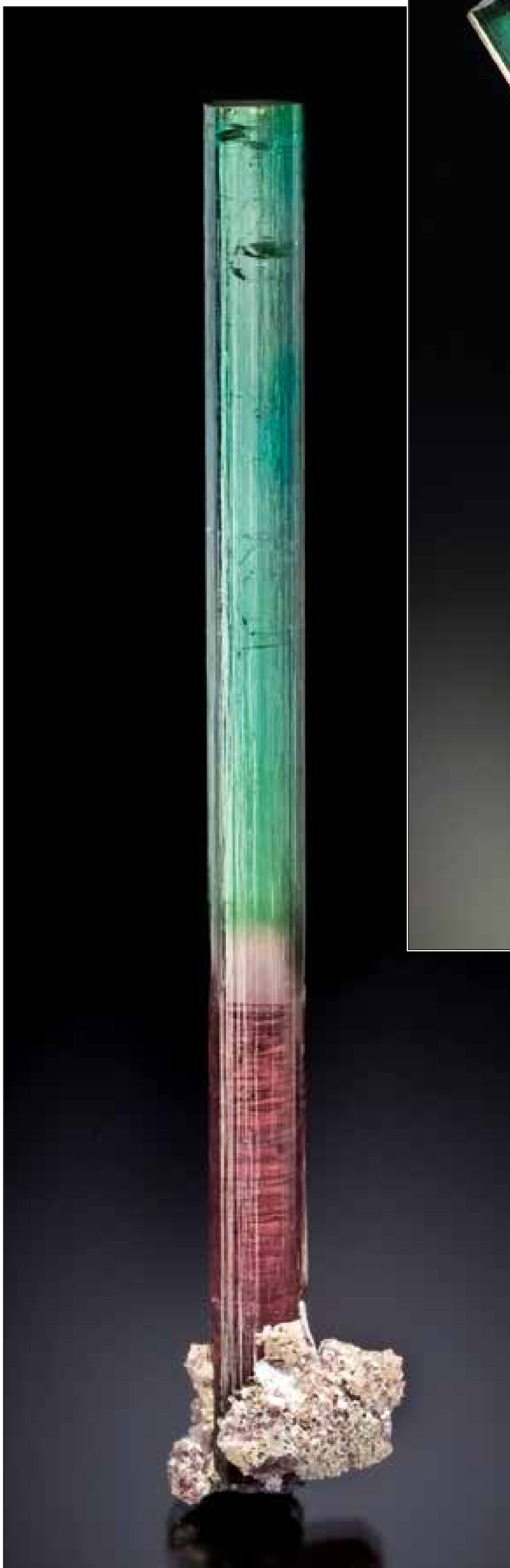


Figure 216. **Tourmaline crystal with lepidolite, 15 cm, from the Bi-color Steel Pocket. Jeff Scovil photo; current owner unknown.**

Figure 217. **Tourmaline crystal cluster on cleavelandite and lepidolite ("Bi-color Steel"), 28 cm, from the Bi-color Steel Pocket. This is the finest specimen ever recovered from the Pederneira mine. Fine Minerals International specimen; James Elliott photo.**

Figure 218. **Tourmaline crystal cluster on feldspar with lepidolite, 7 cm, from the Bi-color Steel Pocket. Gerhard Wagner collection; Roberto Appiani photo.**

Figure 219. **Doubly terminated tourmaline crystal with quartz and lepidolite, 14.6 cm, from the Bi-color Steel Pocket. Stuart Wilensky photo; current owner unknown.**

Figure 220. **Tourmaline crystal on quartz, 13.5 cm, from the Bi-color Steel Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

Figure 221. **Tourmaline crystals on lepidolite with quartz ("Lunch Break"), 33 cm, from the Lunch Break Pocket. This spectacular piece was the only tourmaline in the pocket, and it was nearly destroyed by an over-eager miner. Rob Lavinsky (*The Arkenstone*) specimen; Joe Budd photo.**

***Figure 222*. Shelving in the Pederneira office in Governador Valadares displaying nearly the entire contents of the Lepidolite and Blue Pocket. José Menezes photo.**

Lunch Break Pocket (2004)

Unfortunately, not all stories in mining are pleasant ones. The story of the Lunch Break Pocket certainly falls in the unpleasant category—though it had a happy ending. Sometimes the best intentions can have horrible results. The pocket was discovered in the normal course of mining along the vein. Fortunately it was breached in a way that allowed the miners, led by José Menezes, to be able to open the pocket from a convenient vantage point and begin working to collect the specimens inside.

The pocket was nearly barren of tourmaline except for one extremely large crystal found growing on a mound of cleavelandite, lepidolite and quartz. The quality of this specimen is exceptional, but the rest of the pocket was nearly empty. The pocket was about 2 cubic meters in size and the large tourmaline was attached to the hanging wall in an inconvenient location.

And so began the slow and careful process of peeling away rock from the side of the pocket wall in order to move closer and closer to the specimen. Once the miners were close enough they began drilling, and they continued for days. The objective was, as always, to remove the specimen perfectly intact without a single bruise. The mass of the entire 40-cm specimen was probably around 30 kg. It was an unusual case in which the pocket had not collapsed or otherwise been disturbed, so the specimen was still in place, exactly where it had grown many millions of years ago. After the miners had drilled nearly 100 holes the next task was to crack the surrounding rock with the pneumatic splitter until the specimen broke free and could be plucked from the pocket wall.

After about a week of preparation, the day came when the specimen was to be removed. The team started the morning by splitting the rock nearest to the specimen. By lunchtime the specimen had just started to move, guaranteeing that the prize could be extracted that day. José Menezes called a lunch break and suggested to the extraction team that they go down to the house for a break and come back after lunch to remove the specimen. They did so, but one young miner remained in the tunnel. He saw that the specimen was loose and decided to show everyone how helpful he could be: he decided to finish the job singlehandedly. He took a heavy pry bar, inserted it into one of the holes near the base of the knob, and began to push and pull back and forth on the bar, trying to dislodge the specimen from the wall. After about 30 minutes he went down to join the others for lunch.

He walked into the house with a show of pride, telling everyone "I collected the piece, I did a great job." José Menezes almost choked on his coffee. He spoke up first and said "What piece?"—praying that the poor fool was talking about something else. But the young man replied "the large piece, I collected it for us!" Afraid that all was lost, Menezes slowly stood up, then made a dash to the tunnel and into the mine to take stock of the situation.

Sadly for everyone, and especially for the miner himself whom Menezes wanted to throttle, the piece was indeed "collected." It had fallen and landed on a quartz crystal below it! Menezes, of course felt horror and rage, but the specimen was actually saved by the quartz below it, which blocked its fall and prevented it from crashing down farther into the lowest part of the pocket. And no one was killed on that day.

The tourmaline did suffer a small chip on the termination, but that was far less damage than might have occurred. Needless to say, that miner no longer works at the Pederneira mine and, happily, the specimen was successfully restored in the lab.

Figure 223. **Tourmaline crystal with lepidolite, 17 cm, from the Lepidolite and Blue Pocket. Marcus Budil specimen; Jeff Scovil photo.**

Figure 224. **Four of the finest specimens recovered from the Lepidolite and Blue Pocket. José Menezes photo.**

Figure 225. **Tourmaline with lepidolite on quartz, 13 cm, from the Lepidolite and Blue Pocket. Dylan Stolowitz (*Green Mountain Minerals*) specimen; Jeff Scovil photo.**

Lepidolite and Blue (2005)

All good things, as they say, must come to end, and the Lepidolite and Blue Pocket defined the beginning of the end of the run of discoveries that had begun in 1999 in the Dada Tunnel. Ironically the habit of the tourmaline is nearly identical to that in the first pocket discovered back in 1999, Keké's Pocket.

As the miners followed the mineralized zone, the quality of the pegmatite grew poorer and poorer. They were entering what we believe is the core zone of the pegmatite, where the grain size of the minerals is very large and the frequency of tourmaline pockets is very low.

Luckily, though, the miners hit this one pocket and, considering the visual similarity of the material to that of Keké's Pocket as well as the unpromising quality of the pegmatite, they determined that this was "the end of the line," hence the pocket's name. Pockets found in the tunnel after this time were the result of the miners having gone back through the main drift to probe the sides, ceiling and floor for pockets missed on the first pass. Several were indeed found as they worked their way back towards the front of the mine.

The pocket itself measured about half a cubic meter, but it was not breached in a favorable way and it yielded only a few important specimens. There were several matrix pieces and about a dozen fine crystals but, sadly, no noteworthy specimens could be reconstructed. The four best specimens (as seen in Figure 224) were displayed in the Pederneira house after the reconstruction process was complete.

The pocket specimens have the same gorgeous hot-pink lepidolite that was found in Keké's Pocket, but the tourmaline crystals are slightly different. These crystals are not chrome-green throughout, as are those from the earlier pocket, but are chrome-green at the base and gradually change to a distinct blue color near the termination; the last few millimeters are an opaque yellow-green. This color pattern uniquely distinguishes the crystals from this pocket from all the others and certainly from those from Keké's Pocket.

The best example is a double tourmaline crystal on a small knob covered by hot-pink lepidolite crystals that extend up the entire prism zone of the tourmaline. Aside from the best piece, only a couple of fine single crystals were recovered, along with a few specimens that were not well documented.

Green Scepter Pocket (2005)

The Green Scepter Pocket was the first one found after the miners abandoned further drifting in favor of retracing their steps. The pocket was small and only produced a dozen specimens or fewer. The tourmaline crystals look very much like those from the Rocket Pocket or the Grandon Pocket but they have both the fibrous layer, as in the Rocket Pocket, and the yellow-green terminations, as in

Figure 226. **Tourmaline crystals on cleavelandite with quartz, 17 cm, from the Blue-Green Pocket. Fine Minerals International specimen; James Elliott photo.**

the Grandon Pocket—only these are a bit more yellow, similar to the tourmalines from the Morganite Pocket.

The best specimen is a large plate about 25 cm across and 12 to 14 cm tall. The matrix of cleavelandite and lepidolite is completely overgrown with a forest of beautiful gemmy tourmaline crystals, some of which exhibit the scepter habit that the pocket is named for. As mentioned, the fibrous and/or decomposed zone in the tourmaline crystals is so extensively developed that it has consumed most of the crystals, leaving only the termination caps. These caps are sometimes found grown into other remaining crystals and look as if they are floating. In other cases only remnant tourmaline hairs are found in the empty cavities.

Specimens from this pocket have not yet been released to the market. After the reconstruction process was completed the specimens were stored with the Pederneira Partnership until a few months ago, and are currently undergoing the final lab preparation before sale.

Blue-Green Pocket (2005)

As the year 2005 progressed, the miners encountered another beautiful pocket, which they named the Blue-Green Pocket. It mostly contained long, slender tourmaline crystals with antilogous terminations. The color pattern of the crystals is unique for the mine, shading back and forth from blue to green to blue again (hence the pocket name) up to the termination, where the color becomes greenish yellow. This pattern is more easily seen in person but is visible in Figure 230.

The pocket was not very large, nearing 1 cubic meter, and the matrix is the lovely combination of quartz, lepidolite and cleavelandite that the Pederneira mine is known for. The best specimens have crystals about 2 cm in diameter and up to 20 cm in length. As with the Green Scepter Pocket, most of these specimens were reserved by the partnership. They have been prepared by Mile High Mineral Laboratory but have not yet been brought to the market.

Figure 227. **Tourmaline crystals with minor lepidolite, 7.5 cm, from the Blue-Green Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 228*. Tourmaline crystals with minor lepidolite, 11.6 cm, from the Blue-Green Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 229.* Tourmaline crystals with minor lepidolite, 22 cm, from the Blue-Green Pocket. This is the largest and finest piece recovered from the pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 230*. Tourmaline crystals with minor lepidolite, 18.2 cm, from the Blue-Green Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 231*. Tourmaline crystals with minor lepidolite, 21 cm, from the Blue-Green Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 232*. Nearly colorless tourmaline ("achroite") crystals, 17.5 cm, from the No-Pocket Pocket. This is the only specimen recovered from the very small pocket. Fine Minerals International specimen; James Elliott photo.**

Pictured here are some of the finer specimens from the pocket, showing some of the crystal shapes, sizes and matrix combinations.

The No-Pocket Pocket (2005)

In mining, strange things can sometimes happen. The specimen shown here (Figure 232) is from the only pocket that was really no pocket at all. The No-Pocket Pocket is so named because the pocket this specimen came from was never actually seen. The miners had completed a blasting round and then waited the usual few hours for the air to clear before re-entering the mine to see the results. This time the results were very bizarre. When the miners arrived at the working face where the round had just gone off, there was a specimen lying in plain sight on the floor, as if someone had placed it there! It was broken in a few pieces but the sections of the two crystals fitted cleanly back together, and it made quite a lovely specimen. But there was absolutely nothing else: no cleavelandite, no lepidolite, no quartz fragments, no other tourmalines, nothing! Thus the No-Pocket Pocket, the source of a single specimen.

Like specimens from most of the pockets in the Pederneira mine, this one has its own very distinct characteristics. It is very different from any other specimen collected at the mine that we know of. The two tourmaline crystals are nearly transparent, gemmy from bottom to top, and have beautiful, brilliant luster, but their most unusual feature is their color: about 95% of the body of the two crystals consists of the colorless tourmaline variety called *achroite*, ranging from totally colorless to a steely gray, depending on the light. At the terminations there is a flash of green grading to a solid, opaque black. The effect is striking.

***Figure 233*. Tourmaline crystals with cleavelandite and quartz, 17 cm, from Burkhard's Pocket. Marcus Budil specimen; Malte Sickinger photo.**

***Figure 234*. Tourmaline crystals with cleavelandite and lepidolite, 5 cm, from Burkhard's Pocket. James Elliott photo; current owner unknown.**

Burkhard's Pocket (2006)

Burkhard's Pocket was named in honor of Burkhard Pohl, who joined the Pederneira partnership in 2006. Shortly after he joined the team an important pocket measuring 2 cubic meters was encountered. When discovered, the pocket was totally collapsed, and slowly, shard by shard, it was unloaded, revealing that despite the collapsed condition the pocket floor was relatively intact. The miners were able to collect it all, including even some unrepaired specimens. The largest crystals in the pocket are around 15 cm long, which is not especially large for the Pederneira mine; the average size is about 9 cm.

This relative lack of damage meant that some areas within the pocket had been protected by the way the top portions had fallen down onto the landscape at the bottom. Or perhaps the pocket was still full of fluid which slowed the fall. With patience and the use of the diamond chain saw, we were able to cut out the bottom of the pocket and remove it unscathed (Figure 242). This progression of photos illustrates the step-by-step process from discovery to market for a single specimen, and serves to show also how difficult it can be to collect specimens intact and unbroken. After

Figure 235. **Tourmaline crystals with cleavelandite and quartz, 27 cm, from Burkhard's Pocket. Lyda Hill collection; James Elliott photo.**

Figure 236. **Tourmaline crystals with cleavelandite, lepidolite and quartz, 38 cm, from Burkhard's Pocket. Mark Pospisil collection; Joe Budd photo.**

Figure 237. **Tourmaline crystals with cleavelandite, 8.5 cm, from Burkhard's Pocket. Keith and Diane Brownlee collection; James Elliott photo.**

extraction, cleaning and reconstruction, the specimen is shown on the table in the Pederneira house. Finally, after the specimen has been trimmed and cleaned again in a professional lab, it is ready to be brought to market.

The tourmalines found in the pocket are typical for Pederneira material, terminated in both ways, both styles of crystal being bicolored blue and red. All of the crystals are translucent, and all show very richly saturated colors. The crystals with antilogous terminations start at the base with a red core and blue rind. About two-thirds of the way up the crystal they change to solid blue for most of the remainder, then terminate with dark green to yellow zones.

The crystals with flat, analogous terminations likewise have red cores and blue rinds but carry that pattern through to nearly the

Figure 238. **Tourmaline crystals with cleavelandite, 19 cm, from Burkhard's Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 239. **Tourmaline crystals with cleavelandite, 13 cm, from Burkhard's Pocket. Private collection; James Elliott photo.**

Figure 241. **The only known example from Pederneira showing a tourmaline crystal completely overgrown by quartz crystals; 12 cm, from Burkhard's Pocket. José Menezes photo.**

Figure 240. **Tourmaline crystals with cleavelandite, 8.7 cm, from Burkhard's Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 242. **Cutting specimens out of Burkhard's Pocket with the diamond chain saw. José Menezes photo.**

final centimeter of the crystal, where a blue cap appears suddenly. The terminations are razor-sharp and glassy.

These crystals are the only ones of this habit that have been found at the Pederneira mine to date, and thus are immediately identifiable as coming from this pocket. The albite is distinctly different as well. At nearly 6 mm thick the blades are much thicker than for the typical cleavelandite from other pockets, with little transparency and a very stark, solid white color.

Violet Pocket (2006)

Another pocket that was totally unique at Pederneira was the Violet Pocket. It was relatively small, less than half a cubic meter, but it yielded a dozen specimens in various sizes along with a number of single crystals. Never before or since has this color of tourmaline been seen from Pederneira or any other mine we know of. The color is a true violet, not pink or magenta.

The matrix in most of the pocket was very fine-grained crystallized lepidolite of nearly the same violet color, but there are specimens with quartz and cleavelandite associations as well. Many pieces have highly corroded herderite twins reaching to about 2 cm dotted here and there over the matrix.

The pocket contents have been reserved by the partners until now, and are currently in a cleaning laboratory waiting to come to

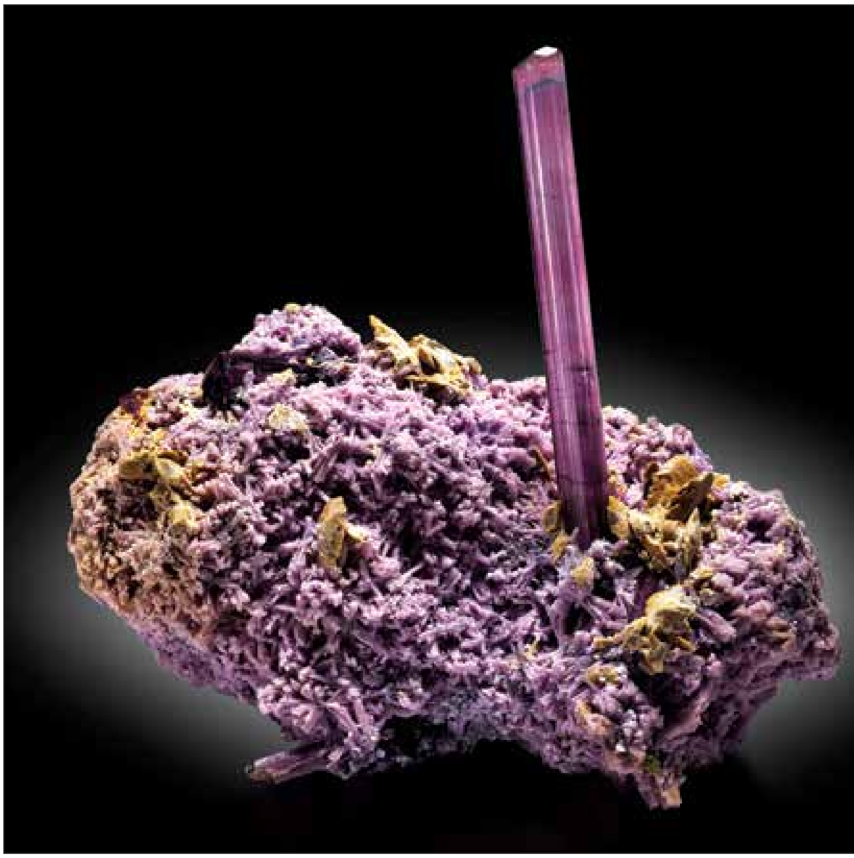


***Figure 243*. Tourmaline on lepidolite, 9.5 cm, from the Violet Pocket. Fine Minerals International specimen; James Elliott photo.**

***Figure 244*. Tourmaline on lepidolite, 21.1 cm, from the Violet Pocket. Gabriel Risse collection; Malte Sickinger photo.**

life. The two specimens pictured here are the only ones that have been processed and brought to market so far. Look for more lovely examples to debut in the coming year.

Blue Gem Pocket (2006)

After nearly seven years of consistent production from Dada's Tunnel, this was the very last tourmaline pocket found in that area of the mine. The bonanza was finally over, although we didn't know that at the time of this discovery.

The pocket was small, no larger than a small beach ball, and most of the value is concentrated into just a handful of specimens. The crystals are a perfect blue color with large gemmy areas that begged to be cut into gemstones. And indeed many were cut, as there were not many salvageable chunks of matrix with which tourmaline crystals could be reunited, and there were many broken singles. Only three or four significant specimens were recovered and reassembled; the best one, the "Blue Gem," is pictured here (Figure 245). The main crystal is 14 cm long and 1.5 cm thick. Although the pocket name is the Blue Gem Pocket, the crystals actually exhibit zones of blue and green blending into one another, similar to specimens from the Blue-Green Pocket but with different hues when compared side by side. And the antilogous terminations of the crystals in the pocket show three sharp faces of the trigonal pyramid that are much better developed than they are on crystals from the Blue-Green Pocket.

Figure 245. **Tourmaline crystal on quartz with cleavelandite, named the "Blue Gem," 17.5 cm, from the Blue Gem Pocket. Fine Minerals International specimen; James Elliott photo.**

Figure 246. **Tourmaline crystals in cleavelandite, 8.1 cm, from the Blue Gem Pocket. Gerhard Wagner collection; Mark Mauthner photo.**

Figure 247. **Tourmaline crystal on a quartz crystal, 12 cm, from the Blue Gem Pocket. Marcus Budil specimen; James Elliott photo.**

Figure 248. **Specimens recovered from the Blue Gem Pocket, prior to cleaning and reassembly. José Menezes photo.**

Figure 249. **Greenish black tourmaline on cleavelandite, 41 cm, from the Black Pocket-II. Mark Pospisil collection; James Elliott photo.**

Figure 250. **Specimens recovered from Black Pocket-II arrayed on a table in the Pederneira office in Governador Valadares. Specimens from the Cranberry Blue Pocket are visible on the shelves in the background.**

Figure 251. **Crystal fragments from Black Pocket-II prior to reassembly in the Pederneira office.**

Quartz Finale Pocket (2006)

Although the Blue Gem Pocket was the last *tourmaline* pocket discovered in the upper tunnel, there was actually one other pocket found. It was the very last pocket to come from the Dada Tunnel and it contained no tourmaline whatsoever. I personally never saw the material and there are no known photos either. The pocket was found very near what we now understand to be the core zone of the pegmatite, where large quartz and feldspar crystals formed. The pocket measured nearly 4 cubic meters and was one of the largest ever excavated at the mine. Reportedly it was filled with lovely quartz crystals to nearly a meter tall, some of them weighing 70 kg or more! The crystals were collected and sold on the local market in Brazil; probably some were sold as specimens and others were transformed into carvings or spheres.

Having reached the end of the pocket-rich part of the pegmatite vein, the partners then began mining the pegmatite in every other direction, but at every turn they met with more disappointing results: barren pegmatite, a monotonous structure, no interesting mineralization in the core zone and no positive indicators. They decided that the mine was done. All of the equipment, electricity, and support for the tunnel was removed and redirected downwards to Dilo's Tunnel, which had begun to be rejuvenated in 2005. The period from 2005 to the present in Dilo's tunnel represents the third era in the Pederneira mining saga. See that section above for more details of what ensued, and continue below for details about the pockets and the specimens recovered.

The Black Pocket-I (2011)

During the nine years between 2005 and the present we cleaned out six pockets in the lower (Dilo's) tunnel, and the total value of the material in those six pockets is about half what we spent on the work.

From the time we began the rejuvenation of Dilo's Tunnel (which had produced so many wonderful pockets during the first era of mining at Pederneira), it took six full, hugely expensive years to produce our first pocket, the Black Pocket-I of 2011. Unfortunately it was not the type of pocket we had been hoping for. Of course, we had been hoping for something amazing; after investing so much time, energy and money, we knew that we would feel let down if the tunnel hit anything less than a major pocket. And that is certainly what occurred. The tourmaline in this pocket was essentially black (actually an extremely dark green). The matrix is typical of Pederneira, finely crystallized with all the usual associations, but black tourmaline is not what the mine is famous for.

We were not sure what to do with the material, so we stored it in boxes in a warehouse. Dr. James Carter from the University of Texas at Dallas had been in the audience during my talk on the Pederneira mine at the 2013 Dallas Symposium, and now he made a suggestion. He asked if we would be interested in donating the pocket of black tourmaline to his university to be reconstructed there. Since we had no real interest in reconstructing the pocket ourselves because of its relatively low economic value, we thought it was a great idea; off the shelves it went and into Dr. Carter's lab, where it is being reassembled today.

The Black Pocket-II (2011)

The next pocket we encountered was again a bit of a disappointment, as we had been hoping for the reds and blues or bi-colors we had heard so many stories about in the past. But, alas, it was another black pocket. This one, though, did give up one truly beautiful specimen.

The pocket was about 1 cubic meter in size and nearly all of the tourmalines have analogous terminations. They are largely opaque, but they do have a flash just under the surface, so that when a light is shone on the prism faces they reflect back a nice green color.

The whole pocket was really just about the one specimen; the others had little to no economic value. The specimen is a wonderful object, with a huge mound of intergrown cleavelandite rosettes and, at the very top, a large tourmaline standing at 16 cm tall and about 12 cm in diameter. There are other, smaller crystals at the base jutting out aesthetically here and there (see Fig. 249).

The Blue Blue Pocket (2011)

The next pocket was—again—not something to get too excited about; it was very small and contained only about half a dozen single crystals. The tourmaline is a bit dark, with a deep blue color and very little green component, hence the name. The only significant specimen is a doubly terminated crystal exhibiting on one end a

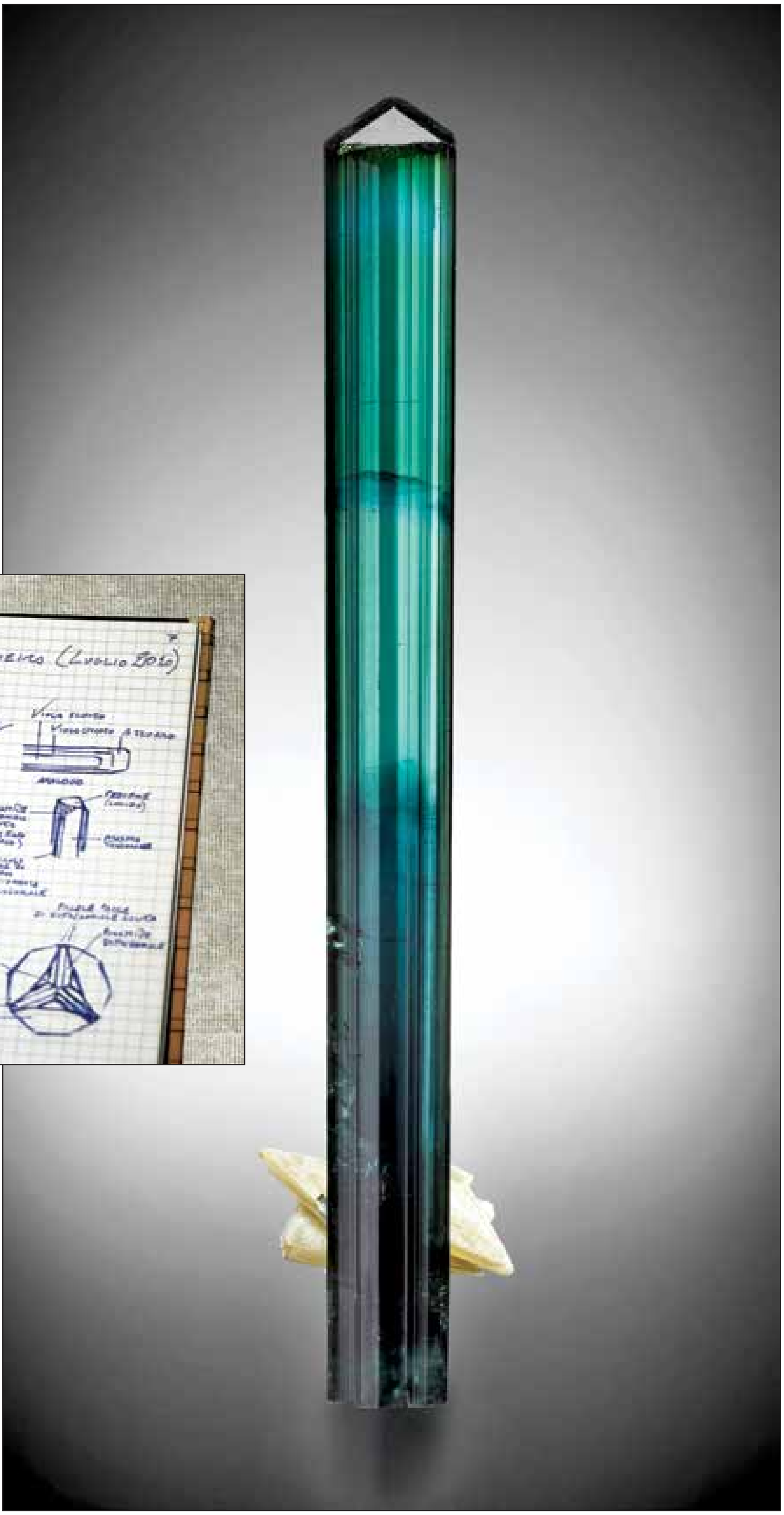


Figure 252. **Doubly terminated tourmaline crystal, 14 cm, the finest specimen recovered from the Blue Blue Pocket. Fine Minerals International specimen; James Elliott photo.**

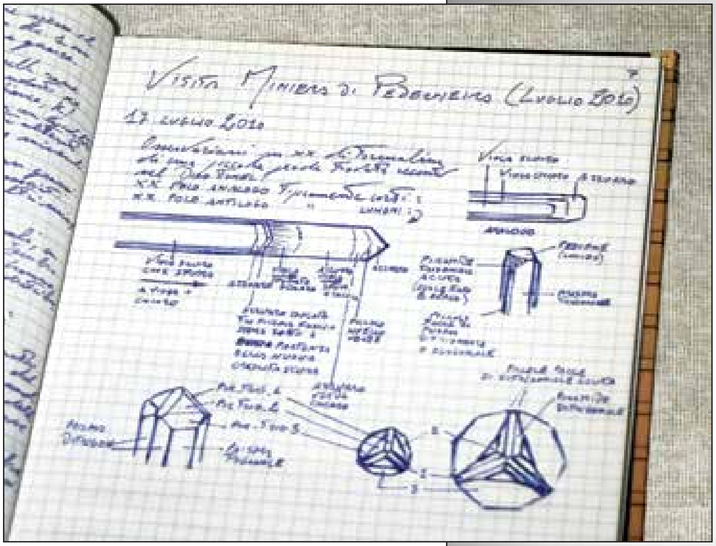


Figure 253. **A page from Federico Pezzotta's notebook with notes on the complex zoning of crystals from the Blue Blue Pocket. Marco Lorenzoni photo.**

pointed termination with a complex set of faces and, on the other end, a perfectly flat pedion termination.

On the crystal are books of "star" muscovite twins forming a small cluster just a few centimeters up from the flat terminated end, providing an elegant association.

Cranberry Blue Pocket (2011)

Finally, toward the latter part of 2011 we had our first glimpse of the famous type of tourmaline that had been discovered years earlier in Dilo's Tunnel. But, although the crystals are lovely, the pocket was not intersected in a favorable way and much of the

Figure 254. **Tourmaline crystal group on feldspar (“the Cranberry Crown”), 19 cm, from the Cranberry Blue Pocket. Mark Pospisil collection; James Elliott photo.**

material removed could not be reassembled. Only three major pieces could be reconstructed from the parts: these we nicknamed the “Cranberry Crown,” the “Great Divide,” and “The Balance,” and each is wonderful in a different way.

The “Cranberry Crown” has crystals reaching almost 20 cm in length with antilogous terminations. This pocket was a first for us at Pederneira; the color is very different from that found in any previous pocket. We had not yet opened any pocket containing tourmaline crystals of a pink or red color throughout, from top to bottom, but the (antilogous) crystals from the Cranberry Blue Pocket are a bright cranberry-red color and the (analogous) crystals are cranberry-colored with blue cores, hence the pocket name. “The Crown” has four major prismatic crystals rising up from a small plate of feldspar and lepidolite. Aesthetically it is one of the most beautiful and memorable specimens the mine has produced.

The “Great Divide” specimen is, as its name suggests, totally great, and the main (analogous) tourmaline crystal is divided halfway up by another crystal (with an antilogous termination) which lies crosswise on the termination. The block of matrix was cut out with the diamond chain saw, and after several months of work cleaning, trimming and reducing the matrix to reasonable proportions the specimen was completed. It is pictured here in the author’s hands, outside the Fine Minerals International house in Tucson just after it was delivered from the lab.

Figure 255. **Tourmaline crystals with lepidolite and cleavelandite ("the Great Divide"), 20 cm, from the Cranberry Blue Pocket. Note extremely large lepidolite crystal to the left of the tourmaline. Private collection; James Elliott photo.**

Figure 256. **Loose crystals from the Cranberry Blue Pocket awaiting reassembly. Marco Lorenzoni photo.**

Figure 257. **The other side of "the Great Divide" specimen (Fig. 255). James Elliott photo.**

Figure 258. **Tourmaline on cleavelandite ("the Balance"), 9 cm, from the Cranberry Blue Pocket. Gerhard Wagner collection; James Elliott photo.**

"The Balance" is nicknamed for its lovely proportions and aesthetic balance. A single tourmaline (analogous termination) is perfectly positioned atop a small group of white cleavelandite crystals.

The Pink and Blue Pocket (2011)

The Pink and Blue Pocket was not very large and produced almost no matrix specimens. But the color of the tourmaline is, once again, unique: it has tones of pinkish red and vibrant blue, neither of which look like colors from any other pocket we have come across. Sadly, most of the crystals are damaged, and the "matrix" itself is really just a jumbled mass of smaller tourmaline crystals.

The color is quite lovely, but the quality of the specimens leaves something to be desired. The colors of the (analogous) crystals start with a pink core and blue rind, leading up to a vivid blue termination that is pink again in the last fraction of a millimeter. This color scheme is beautiful, but only a few high-quality specimens could be reconstructed.

Thiago's Pocket (2012)

Despite the string of respectable pockets found in 2011, and despite all of our efforts to identify subsequent target zones in the pegmatite, nothing was produced for much of 2012, and the cost of searching was not being recouped. Since the discovery of the Pink and Blue pocket, nothing had been found through mid-September 2012. Thiago Menezes, José Menezes's son, was by that time the

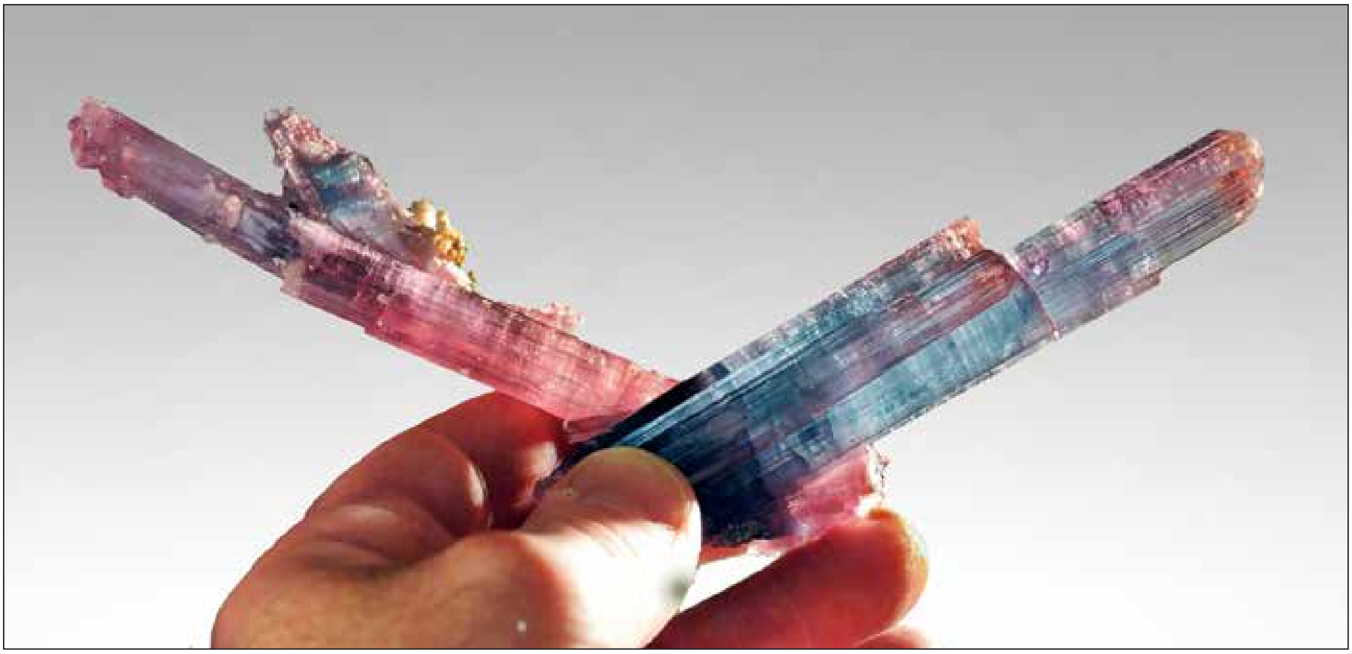


Figure 259. **Tourmaline crystals, 12 cm, from the Pink and Blue Pocket. Fine Minerals International photo; private collection.**

Figure 260. (below) **Tourmaline crystal, 9 cm, from the Pink and Blue Pocket. Fine Minerals International photo; private collection.**

Figure 261. **Bryan Swoboda and Federico Pezzotta looking over crystals recovered from the Pink and Blue Pocket in 2011. Fine Minerals International photo.**

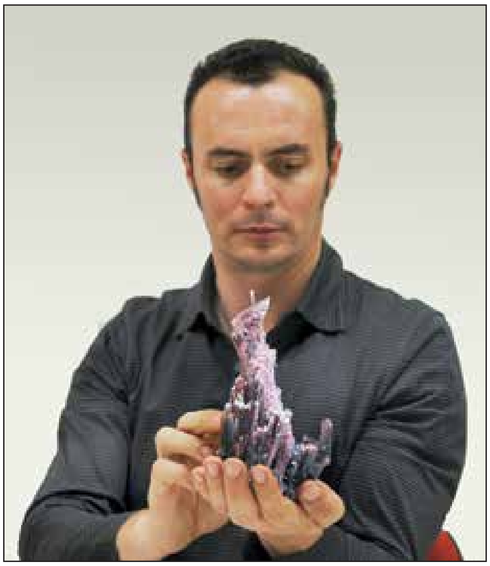


Figure 262. **Federico Pezzotta examining an unusual tourmaline from the Pink and Blue Pocket. Fine Minerals International photo.**

***Figure 263*.**
Tourmaline on quartz, 17 cm, from Thiago's Pocket; the only unrepaired specimen found there. Private collection; James Elliott photo.

***Figure 264*.**
Tourmaline with quartz and cleavelandite, 30 cm, from Thiago's Pocket. Fine Minerals International specimen; Chris Vaughn photo.

main partner monitoring the operations at the Pederneira mine. After trying a blast to connect two areas and widen another they came back into the mine to find an opening into a 2-cubic-meter pocket filled with deep blue gemmy tourmaline crystals! Finally, after nearly seven years of fruitless work, a significant pocket had been discovered.

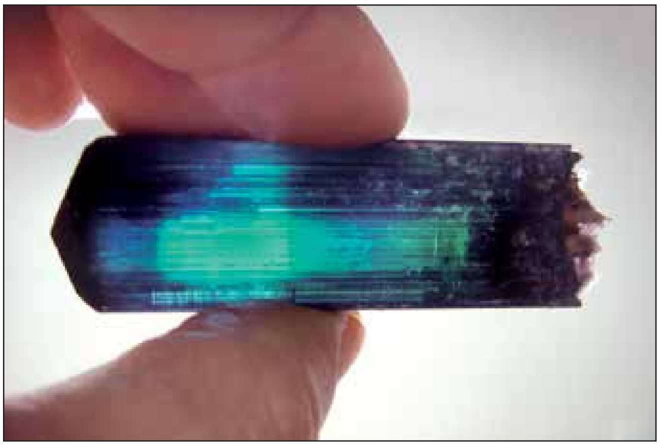
The (antilogous) tourmaline crystals are heavy with inclusions at the base; the cores of crystals found in other pockets are typically translucent but here they are opaque. As with crystals found in the Rocket Pocket, there is much corrosion-related fibrous tourmaline between the outer zones and the cores of crystals, leading to a number of variations in habit. Some crystals have been so eroded and etched that the entire bottom section of the crystal is missing—or, rather, transformed into what looks like an irregular paint brush with bristles of different lengths—while the gemmy termination area has remained unaffected.

In another habit found in this pocket the fibrous layer is not as heavily decomposed, and the rind is still totally intact. These crystals have a silvery sheen just below the outer zone when a light is

Figure 265. **Tourmaline crystal group on lepidolite, 25 cm, from Thiago's Pocket. Fine Minerals International specimen; Chris Vaughn photo.**

Figure 266. (below left) **Tourmaline crystal (5 cm) with one corroded termination, from Thiago's Pocket. Fine Minerals International specimen and photo.**

Figure 267. **Tourmaline crystals on quartz before cleaning, 17 cm, from Thiago's Pocket. Note the corroded lower end of the crystals. Fine Minerals International specimen and photo.**



shone on them for the first half to two-thirds of their length, then sharply and vividly they shift to gemmy blue, with almost no green component at all, and totally flawless.

Several incredible single crystals were recovered that have these paintbrush-style bottom ends and could therefore no longer be reunited with the matrix positions where they once grew, as the broken surface of the crystal base has been dissolved to nothing. But they do make fine cutting rough.

This pocket produced nearly 4 kg of the highest possible quality blue tourmaline rough. The crystals had more value as rough than as specimens, so they were cut into beautiful gems.

The uncorroded crystals that could be reattached to matrix were happily returned to their original locations and now are some of the most spectacular specimens the mine has seen in years.

Figure 268. **Tourmaline crystals and matrix from Thiago's Pocket wrapped and boxed for shipment to the preparation lab. Fine Minerals International photo.**

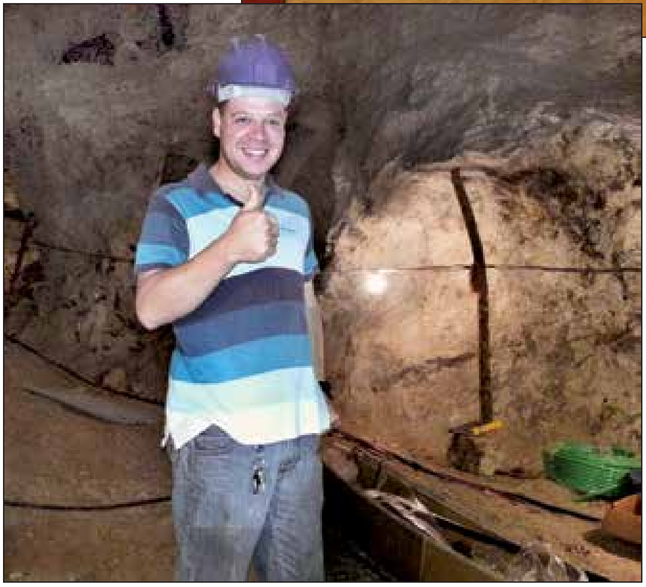


Figure 269. **Thiago Menezes underground at Pederneira in 2014. Fine Minerals International photo.**

Only one specimen from Thiago's Pocket has thus far gone through complete laboratory processing because it was collected totally unbroken and merely needed cleaning. The tourmaline crystals on this specimen penetrate the termination of a lovely citrine quartz crystal; the bottom ends of the crystals are totally dissolved away, exhibiting the "paintbrush" look.

There are about 15 significant specimens from the pocket, all currently in the lab being professionally cleaned, trimmed and prepared.

Conclusions

Once the current drilling program has been completed we will know for sure whether there is another life in store for the Pederneira mine, or whether she will be closed, perhaps forever. Our hunch is that before long the Pederneira mine will be sharing a whole new array of tourmaline specimens with the world. But in mining nothing is certain, and whether or not we are able to locate a dozen new and wonderful pockets to share with collectors, one thing is certain: Pederneira will go down in history as one of the all-time great mineral specimen localities the world has ever known.

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