The PURPLE HOPE Claims

Figure 1. Joe George drilling on rope, Purple Hope No. 4, June 2015. Tad Dillhoff photo.

Green Ridge
Middle Fork of the Snoqualmie River
King County Washington

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FEW COLLECTORS outside the Pacific Northwest are aware of the exceptional quartz specimens found in King County, Washington. Only two King County quartz localities have ever been featured in national publications: Denny Mountain (Ream 1977; Jackson 2008a) and the Spruce claim (Medici et al. 1978; Lasmanis 1991; Jackson 2008b, 2015). "Rockhound Gulch" on Denny Mountain has long been known for an interesting suite of skarn minerals that can be collected in a narrow canyon on the west slope of the mountain (many of them have fallen from the cliffs above). Near the top of the canyon a small zone produces beautiful amethyst scepter groups and quartz specimens with Japan-law twins that reach 30 cm across. The Spruce claim is most famous for pyrite and quartz combinations, sometimes with associated ankerite, calcite, or barite. Beautiful plates of amethyst scepters and excellent Japan-law twins have also been found at Spruce but are so uncommon they seldom make it to the marketplace. Here we introduce another King County amethyst scepter and quartz twin locality, the Purple Hope No. 2 and No. 4 claims, located on Green Ridge, to the east of Mount Garfield (fig. 3).

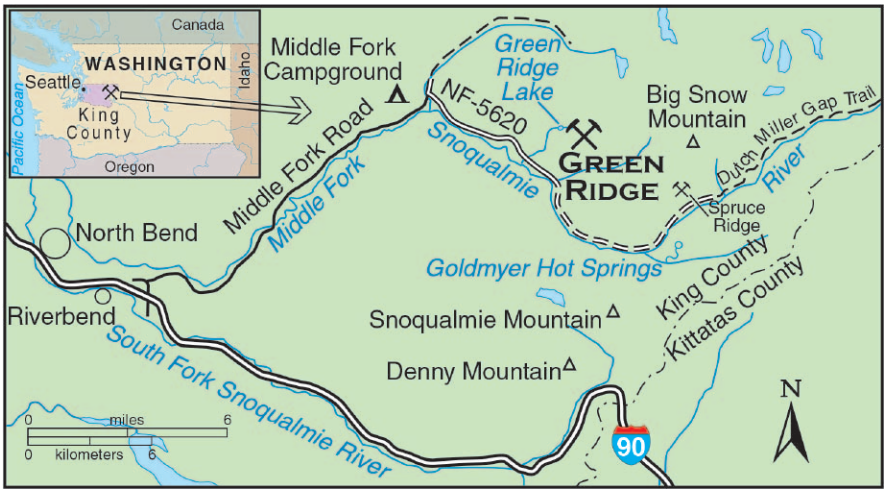
Figure 2. **Amethyst, 3 × 4.5 cm, Rolling Thunder Pocket, Purple Hope No. 4, collected July 2013. Jeff Scovil photo.**

Collecting in the Cascades

In absolute height, the Cascades may not seem like formidable mountains. The highest peak in King County is Mount Daniel, approximately 2,425 meters. Mount Garfield, the peak nearest to Green Ridge, is 1,683 meters. However, the trailhead starts at about 300 meters, so the climb is through 1,000 meters of increasingly steep, forested slopes, and the deposit is near the top of sheer rock faces hundreds of meters high. To get to those rock faces the hike penetrates one of the most prolific temperate rainforests on earth; new trails and even roads can disappear within a few seasons. Then there is the climate: freezing, wet, or (rarely) sunny. Collecting is impossible when everything is frozen, and the sunny season is short. Most collecting occurs in the wet seasons, late spring or early fall, when it is only too apparent how the Cascades got their name. A typical day consists of setting off for a hike in the rain at dawn, punctuated by thrashing through wet thickets of devil's club and vine maple, and finally emerging onto loose talus to face a very steep climb in wet gear to the locality. Once there work is on wet vertical faces while lying in mud or running water to collect a pocket. Rain gear helps (marginally), but with the exertion of climbing and rock wrestling collectors usually end up just as wet inside their gear as outside. Many of us opt to just spend the day wet and leave some dry clothes waiting in the car for the end of the day.

The green at Green Ridge can only be appreciated during the brief dry spell in the summer. The locality is unaffection-

Figure 3. **Locality map, prepared by William Besse.**



Rick Dillhoff has been a King County mineral collector for nearly forty years. He is chairman of the Evolving Earth Foundation (http://www.evolvingearth.org) and, as curatorial associate of paleobotany at the Burke Museum of Natural History and Culture, University of Washington, has published research describing plant fossil occurrences in the Pacific Northwest.

Joe George is a field collector, currently marketing fine quartz crystal specimens under the name Cascade Scepters, aka Scepterguy. He has a bachelor of science degree in engineering geology from Western Washington University.

Figure 4. **Sunset behind Mount Garfield, taken on rope from Purple Hope No. 2, August 2015. Joe George photo.**

up; however, ropes are provided. The traverse from there is very scenic if you aren't in the middle of a cloud. Our main working face is an approximately 50-meter sheer face. We maintain a narrow working bench that is more or less horizontal, but much of the drilling must be done on rope (fig. 1).

In spite of all the challenges, on a good day Green Ridge can be magical. Setting up for the season and transporting specimens at the end requires skillful helicopter support to use our tiny landing zone (fig. 7). Stepping off the helicopter onto an alpine meadow certainly seems like magic compared to the usual long, nasty hike required to get there. From the landing zone everything has to be carried to the working face. Figure 6 shows our original campsite with the Purple Hope No. 2 face in the background to give a sense of the elevation gain from camp to the workings. Purple Hope No. 4 is at the same elevation, to the west of Purple Hope No. 2. Camp

Figure 5. **Camping at Green Ridge, October 2012. Joe George photo.**

ately known as Gray Ridge the rest of the time. In winter the snowpack can exceed 6 meters in camp, so some years the collecting season doesn't start until July. New snow starts falling by early October. Spring and fall days are short, and the working face is cold and wet. Camping conditions are a challenge. Figure 5 gives an idea of what one can wake up to on a cold October morning. On the rare sunny days the scenery becomes a distraction, but we have also had trips in July when we could barely see our hands in front of our faces for days on end. Even though it may not be raining, the fog soaks through to the skin, and temperatures can be only a few degrees above freezing. It's the summer trips that can turn into surprise horror movies when the thunderstorms hit.

When the clouds do part, collectors are the only warm-blooded animals larger than a pika within miles. There will be bugs. We wear netted bug hats and long sleeves most of the collecting season; an unprepared collector can just about go insane from the insects. No matter how cold and wet the morning may be, the trip from camp to the main collecting face will warm you up fast—the first 200 meters are straight

Figure 6. **Camp with Purple Hope No. 2 working face in background, July 2009. Rick Dillhoff photo.**

Figure 7. **Helicopter landing zone, October 2012. Joe George photo.**

is on one of the few flat spots on the mountain, in a grove of huge virgin-growth mountain hemlocks and alpine firs. There is nothing to compare to kicking back around the campfire at the end a successful day to enjoy the sunset behind Mount Garfield (fig. 4).

History

The first record of specimen collecting at Green Ridge that we could discover was by the Faddis brothers, David and Carl, in the late 1950s. In 1960 local collector Lew Landers first heard about crystals in the talus above Quartz Lake from his high school gymnastics coach who belonged to a group that planted trout fingerlings in the alpine lakes. A year or two later Landers saw Green Ridge crystals displayed at a Seattle rock show by the Faddis brothers and decided he had to find the locality, immediately! He headed up later that same day with a friend. Apparently the Faddis brothers detected his enthusiasm; they were waiting that evening when he finally arrived late in the day after a particularly arduous climb because he didn't know the route in. They were gracious enough to invite him to dinner; there were plenty of crystals for everyone. Landers described open pockets from the early days as being full of loose plates "stacked like cordwood" (Landers, pers. comm., October 2013).

In late July 1981, three collectors, Lanny Ream, Randy Becker, and one of us (RD), climbed to Green Ridge to stake the Purple Hope claims on Ream's behalf. Ream had found a large pocket containing amethyst scepters and pyrite-phantomed quartzes the year before, and the specimens convinced him the deposit had commercial potential. That pocket was located on Purple Hope No. 1. Shortly after staking the northeast corner of Purple Hope No. 2, Dillhoff broke into a virgin pocket at the base of a sulfide-stained wall and refused to take another step. Ream and Becker could go on to locate the other corners. The entry to the pocket was blocked by the remnant of a huge (30-cm) former pyrite crystal, consisting of an intact goethite pseudomorph shell with a core of bright corroded pyrite remnants. After sacrificing the pyrite, the pocket developed into an arm's-length tube lined with bright clear quartz and doubly terminated clusters in the back chamber. Climbing down to camp in lengthening shadows with too many crystals and a big smile—how could it get any better than this?

Ream later sold the claims to Bob Jackson who negotiated a plan of operation with the Forest Service and commenced initial exploration. Jackson conducted small blasting operations, including a month and a half when Mark Kielbaso worked the deposit, but not enough was produced to convince Jackson that the claim was commercially viable. Given the long steep climb and the cost of helicopter support, he decided to focus on other claims in the Middle Fork valley. When the Bureau of Land Management instituted annual filing fees and limited the small miner exemption to holders of ten mining claims, Jackson decided to sell some of his, including the remaining Purple Hope claims. We own Purple Hope No. 2 and No. 4.

Geology

Green Ridge is located to the east of Mount Garfield within the Snoqualmie batholith, which exceeds 580 square kilometers (224 square miles), extending roughly from Interstate 90 to US 2 in eastern King and Snohomish counties. It is a composite batholith resulting from at least eight separate magma pulses, with the younger phases becoming increasingly felsic (Erikson 1969; Cheney 1999). The most common exposed rock is main-phase granodiorite although local variations can range from gabbro through diorite to quartz monzonite (Gualtieri and Simmons 1989). Radiometric dating of the southern portion of the batholith ranges from 16.9 (±2) to 20.5 (±2) Ma (millions of years before present) placing it in the Early Miocene (Tabor et al. 1995). The younger ages may represent resetting during the intrusion of younger phases of the batholith.

Studies of nearby mineralized zones at Quartz Creek to the west and the Snoqualmie mining district straddling the Middle Fork of the Snoqualmie River have resulted in a generalized model of the environment for sulfide deposition in the Snoqualmie batholith. In the Middle Fork zone, northeast-trending shears produced zones of alteration and brecciation, particularly at the intersection with steeply dipping northwest-trending faults. Deuteric alteration of quartz deficient zones resulted in a loss of volume of up to 30 percent. Subsequent solutions rich in potassium, iron, sulfur, copper, and minor molybdenum enriched these zones. These occurred in multiple pulses, with late-stage assemblages of sericite, pyrrhotite, quartz, carbonate, and chalcopyrite (Grant 1969; Patton, Grant, and Cheney 1973).

A single published report (Thurber et al. 1989) specifically describes the breccia zones around Green Ridge Lake. The

main outcrop is mapped as quartz diorite although a body of schist and tactite outcrops near the east end of the Purple Hope No. 2 breccia. Individual breccias were measured as long as 762 meters. The breccia is cemented by quartz, sulfides (primarily pyrite), and mica; much of the cementing silica consisted of quartz crystals, "a small percentage of them amethystine" (Thurber et al. 1989, p. 220). From the miner's experience, the breccia at Green Ridge is composed of much larger blocks than those typical of the Middle Fork claims further up the valley. Blocks of host rock are usually in their original orientation and angular at Green Ridge, whereas the typical Middle Fork breccia is composed of rotated, rounded blocks. The condition of the breccia blocks at Green Ridge would be most consistent with a collapse breccia or shatter pipe. Pocket density tends to be lower at Green Ridge than at other Middle Fork breccias, but pocket and crystal size tends to be larger. Another major difference between Green Ridge and the other breccias is the absence of carbonates. Calcite, siderite, and ankerite are found in most of the upper Middle Fork breccias but are completely absent at Green Ridge. The carbonates that were deposited by late-stage injections into the Middle Fork breccias (Grant 1969) must not have occurred at Green Ridge.

Early Collecting at Green Ridge

Early collecting at Green Ridge was basically a matter of scaling the cliffs and looking for an open pocket. The long hike in precluded carrying a bar heavier than a collector could use as a walking stick. Pockets could be huge, and cleaning them out was mostly handwork anyway. Although some pockets contained crystals still attached to the pocket wall, loose plates with re-terminated crystals on the back, fallen to the floor, were the norm. No tools were required to collect these other than chopsticks or a screwdriver to loosen the debris and limonite around the plates. Hard decisions had to be made based on how much weight we were willing to carry on the long trip out. There were a few very large open pockets that could be crawled into, and in a couple of cases they were high enough to stand in. Although they usually contained mundane, frost-damaged quartz plates, there were some with protected treasure chambers. Dillhoff collected his first large amethyst in the back of one huge open pocket by chopping the head off his sledge hammer handle and sharpening it into a chisel point to remove the specimen from the ceiling and fish it out.

In 1985 Dillhoff collected a quartz seam that ultimately opened into the pocket that became known as the Colacurcio Pocket, named for the young man who spent the entire summer of 1987 collecting it. This was more cave than pocket—15 meters in length, not counting the couple of meters that had been eroded off the front exposing the gigantic quartz seam that fed it. The main chamber contained several layers of collapsed ceiling plates, each followed by regrowth of another generation of quartz. A number of large Japan-law twins were recovered, but many crystal plates were simply too large to carry out. In the furthest back reaches of the pocket the darkest amethyst that had been found at Green Ridge up to that point was discovered. The pocket seemed to be an outlier though, as others in the nearby area were small for Green Ridge, and although the quartz was very bright, the color was faint. Steep cliffs made further hand-collecting in this area a difficult proposition.

George first learned of the Green Ridge locality as a budding field collector in his teens. After helping to pack summer supplies up to the Spruce claim, he asked Jackson if there were any more crystal collecting localities in the area. Perhaps as an initiation test to see if George had the necessary skills and devotion, Jackson gave only vague directions to the locality. "Go up that mountain, and just stay to the left of the creek. When you get to Green Ridge Lake, look up, and you should find lots of crystals on the peak—let me know if you find anything really great" (Jackson, pers. comm., 1992). He pointed out the correct drainage to start from and left it at that.

Later that summer, George and his dad, Jack, decided to try an outing to find the claim. Despite dense, wet underbrush and little more than an intermittent animal path to follow, they persevered (trail access hasn't changed much to this day). Particularly thick fog permeated the woods that day. Determined, they continued up through the dense forest until breaking out above the clouds. Green Ridge Lake lay shining in the sun, surrounded by rock walls. The essence of Jackson's directions was completely accurate; no matter where they looked on the peak, they found crystals. In some places the forest soil literally sparkled with them! After that first brief visit, George told Jackson that if he ever wanted to sell the Green Ridge claim, to please give him the opportunity to buy it. Nearly eight years later, in October 1998, George got that call. The first night on the claim after he had agreed to the purchase was spent alone, absolutely soaking wet with inadequate gear—it wasn't exactly the collecting paradise George had imagined, but it would turn out to be worth the pain.

The discovery of the citrine zone in 2001 was a complete accident. While traversing the mountainside off-trail to find a nice spot for lunch, one of George's friends literally stum-

Figure 8. **Japan-law twin, specimen 7 × 12 cm, Nacho Bench, Purple Hope No. 4, collected 2002. Jeff Scovil photo.**

bled into a large hole between two blueberry bushes. The pocket, large enough to fit two people inside, was open to the elements. It certainly looked like a good place to have lunch. The initial chamber had solid white crystals on the walls with individual crystals to 10 cm across and broken-off prism pieces to 20 cm long on the floor. Everything in the first chamber was heavily frost damaged and filled with white fog and microfractures. Upon working into the pocket floor and breaking open an adjacent chamber, they found a few brilliant crystals with high clarity and luster. Despite shining a flashlight into the opening of the second chamber, the other end of the pocket was not visible. This was a *big* pocket! Following the vein in the granodiorite, George was able to break into the back of the pocket, 7 meters away. Unfortunately, most of the quartz was heavily frost damaged in this part of the pocket as well, but one small chamber held several large undamaged crystals. At first the yellow color of the crystals was assumed to be iron staining, but despite all cleaning efforts the color persisted.

In 2002 George relocated his working bench to a prominent ridge on the west, thinking there could be virgin ground due to the difficult access. The upper half was nearly devoid of pockets, but a zone in the middle occupied by small trees proved to have some of the highest pocket density on the mountain. The first two pockets were a pair of side-by-side 1–2-meter-deep holes. A water-clear 7-cm Japan-law twin (fig. 8) greeted George at the entrance to the first pocket. Located at the bottom of the zone was the Nacho Cheese, a large pocket, more than 4 meters wide by 0.5 meter high, that yielded several 10–15-kilogram plates covered with low-lying, brilliant, pale amethyst-tipped drusy quartz crystals. When found, the plates had a bright red-orange iron oxide crust, closely resembling the powdered cheese one finds on popular snack chips. Thus, Nacho became the name of the bench.

The following year George helicoptered a small cabin to the top of a precarious ridge just below the bench. Steel cables attached to a large old-growth tree above held the cabin in place, and only one edge of the cabin rested solidly on the ground. The other three sides hung suspended in the air with only thin supports. One of the first guests insisted on donning a harness and roping up before taking a midnight bathroom break. This spot was utilized for its close proximity to the working face, but we ultimately had to abandon the site for safer surroundings.

In the summer of 2002, Jackson offered the Purple Hope No. 2 claim to Dillhoff. The area was wilderness, so no more claims could ever be staked. Purple Hope No. 1 had been returned to the U.S. Forest Service, and Purple Hope No. 3 was lost by an owner who missed his renewal filing deadline. This would be the last chance to see what Green Ridge really held. Dillhoff was starting to have knee problems and was well aware of how much work it would be to collect at Green Ridge, but twenty years later the memory of his first pocket remained fresh. Purchasing the Purple Hope No. 2 where he had hit that first pocket felt like destiny fulfilled. Besides, an unnamed mineral dealer had made an offer to purchase the claim. Jackson knew how to motivate Dillhoff.

Figure 9. **Sceptered Japan-law twin, 3 × 5-cm twin, Desperation Pocket, Purple Hope No. 4, collected September 2009. Jeff Scovil photo.**

Developing Purple Hope No. 4

While excavating the Nacho bench in the summer of 2008, George dislodged a particularly large boulder that scoured a 2-meter-wide bunch of blueberry bushes off the vertical face 30 meters below, exposing several small amethyst crystals in what was left of the blueberry bush roots. Probing a crack at the intersection of the pocket trend and the recently ravaged blueberry bushes revealed a small hand-sized hole. The first crystal to come out was a 4-cm glassy amethyst scepter, then another amethyst scepter, followed by two more in the next handful! It did not take long for George's companion, Jeff Schwartz, to offer his help. When collecting on a rope, everything that comes out of a pocket must immediately be wrapped and secured. A misplaced specimen on a ledge may easily fall to its doom. George was keenly intent on wrapping every crystal carefully, and before he could ask for a turn at the pocket, Schwartz would hand him another and another amethyst scepter; it was like a candy machine dispensing Scooby Snacks. The Scooby Snack Pocket produced the most brilliant amethyst any of us had seen from Green Ridge. The pocket was lined with sericite, and most of the scepters were loose in the bottom of the pocket. The best specimen is a 3 × 10-cm doubly terminated amethyst scepter.

That winter we agreed on a plan for our first mining attempt together the next season. In July 2009 we flew in a drill, hand tools, and camping supplies and surveyed both claims. There was no shortage of opportunities, but we agreed to focus on the area around the Scooby Snack Pocket despite the steep terrain because that pocket had produced the most brilliant amethyst we had found at Green Ridge. Access in 2009 was particularly challenging; a bridge washout at Taylor River meant wading the river there and added an 8-kilometer mountain-bike ride to the trailhead, but George was determined. In early September near the end of a long day, he discovered another substantial pocket under crumbling rock around a group of small trees where the cliff below the Scooby Snack Pocket turned the corner into a small vertical canyon. Extremely careful work was required not to undermine the tree roots above or lose crystals to the canyon below. When the first large plate was flipped over, George was greeted with a Japan-law twin with sceptered "ears" (fig. 9).

Figure 10. **Queen of Desire, amethyst scepter, specimen 7.5 × 9 cm, Desperation Pocket, Purple Hope No. 4, collected September 2009. Jeff Scovil photo.**

Sceptered twins are considered the holy grail by many quartz collectors here in King County. Two were found near the entrance of the Desperation Pocket, and both were on matrix!

A week later, after two days of effort and 2 meters further into the face, reaching blindly around a corner into the back chamber of the pocket, a large scepter head could be felt. Even to the touch, it was clearly a special piece. With just a light tug, a nearly hand-sized floater matrix plate with an egg-sized scepter tumbled out. The scepter (fig. 10) has excellent clarity, and wispy purple amethyst phantoms stacked in the center extend the full length of the crystal. This was the specimen of George's dreams and was christened his Queen of Desire on the spot. Of course, if there's a queen, there must be a king. When George got the mouth of the back chamber fully open, a monster amethyst, 9 × 4.5 cm, could be seen hanging from the ceiling, completely out of reach. It would not see the light of day for far too long.

Another mining commitment kept George busy in early 2010, and we took a collecting trip to Switzerland in August of that year, so work at Green Ridge was limited to attempts to finish the Desperation Pocket. There was just no way to move enough rock by hand while working on a near-vertical face. We would have to somehow drill and blast around the pocket.

In 2011 we agreed that we should explore the rest of the deposit, and George spent the summer drilling 144 holes at four different locations on both claims. He drilled the beginnings of what has become the main bench and managed to get holes around the Desperation Pocket. He also drilled at two nearly vertical locations on Purple Hope No. 2. We flew in, along with Bob Jackson and Marcel Gerig, who had been our guide in Switzerland the summer before. The main face blast provided a nice bench for future operations and exposed a series of interesting pockets with pyrite-included quartz but no major finds. Blasting around the Desperation Pocket opened it considerably, but the back chamber was still beyond our reach. Dillhoff had wrenched his back the previous day, so he stayed behind in camp the next morning and hid behind an old-growth log during the blasting of Purple Hope No. 2. The decision to take cover turned out to be a wise one—rock fell perilously close to camp. We would have to rethink dynamiting at that collecting spot. Although we felt like much had been accomplished, no major specimens had been found since the Desperation Pocket in 2009. It was time to get serious.

Our explorations convinced us to refocus on Purple Hope No. 4 in the 2012 season. Our first goal was to open the Desperation Pocket. This would entail cutting a bench but would hopefully open other pockets. Archer McGill was recruited to mine with George. The King was finally collected in early July 2012, nearly three years after discovery, by blasting a bench into the cliff and removing extensive overburden to reach the back of the Desperation Pocket. It took nearly two weeks. However, no other substantial pockets were encountered despite the amount of rock removed, so operations were relocated to the main bench to the east where we had test blasted the year before. Breccia blocks in this zone can be huge, sometimes exceeding 20 meters in length. That meant dealing with large zones of barren rock, but the 15-meter Colacurcio Pocket was found at the base of one of those barren blocks. Perhaps there were more? We dreamed of better, but nothing of consequence was found in the last week of dynamiting, and McGill was scheduled to proceed to the Spruce claim for the rest of the summer.

Figure 11. **Reichenstein-Greiserntal-law twin (Greiserntal form), specimen 9 × 19.5 cm, Turning Point Pocket, Purple Hope No. 4, collected August 2012. Jeff Scovil photo.**

The day after McGill left, George opened a new chamber in the back of an open pocket on the main face and saw a huge twin hanging from the roof at the back of the pocket. George could see this was no ordinary twin. It may be the largest Reichenstein-Greiserntal-law twin known (see sidebar, p. 506). We were not prepared to wait three years for this one! The next day Dillhoff was dispatched to climb to the Spruce claim and persuade McGill to come back and help open the chamber. It required many beers to convince McGill to make the long climb to Green Ridge the next morning. Dillhoff succeeded, but all that persuasion made for a hazardous climb down from Spruce. A very long day of maximum effort and three small blasts produced the largest twin found to date at Green Ridge—9 cm high by 16 cm wide (fig. 11). The flawless interior of the crystal has a pale smoky/citrine coloration visible as a sharp phantom in the largest twin ear. With a burst of optimism, George named the pocket the Turning Point Pocket. This part of the deposit clearly warranted more work!

Thunderstorms during the 2012 season convinced us we needed better shelter than the tents we had been working from, but the Forest Service would not permit us to build a permanent cabin on-site. The mining plan did allow for a cabin to be flown in and out each season, but besides the cost, it would have meant placing the cabin in a very visible spot on the shore of a pristine alpine lake. Finally, a helpful Forest Service employee suggested we look into the provisions for "temporary structures." We negotiated permission to erect and store a remarkably cabin-like temporary structure at the claim as long as it wasn't built on a permanent foundation and was disassembled at the end of each season. We built the Crystal Palace in George's back yard with the help of his kids. It is constructed in 1.3 × 2.6-meter sections, held together with lag bolts for easy assembly and disassembly. Our pilot managed to snake two big bundles between the trees to a well-hidden flat spot near our landing zone. Our temporary structure is disassembled at the end of each season, and a picture was sent to the Forest Service for documentation.

Now we were ready for whatever the mountains threw at us. The 2013 season opened with great expectations and visions of more huge twins. Our expectations were more than fulfilled, but our vision turned out to be a little foggy. We found more than a dozen Japan-law and Reichenstein-Greiserntal-law twins in 2013, but only the best one is counted among the top five specimens for the season. Instead of twins, 2013 produced the best amethyst-scepter plates ever found at Green Ridge to that point, from three pockets that defy ranking. They were all great. Our "Purple Hope" was finally fulfilled.

The first—the Rolling Thunder Pocket—was named for the day's weather conditions. At least the miners knew a warm, dry temporary structure awaited them at the end of the day. George had pried a large flake off the face, and McGill, working below, told him there was an open pocket with a pile of loose scepters in it. George said to go ahead and collect it, then nearly fell down the cliff when he saw what McGill was pulling out. This pocket was reminiscent of the Scooby Snack Pocket, lined with a matrix of tiny quartz crystals and a thin layer of fine-grained sericite containing particularly brilliant crystals of the deepest amethyst color. As with the Scooby Snack, loose scepters that had fallen from the ceiling and walls when they became too heavy for

Figure 12 (left). **The Thunderbolt, amethyst scepter, specimen 12 × 21 cm, Rolling Thunder Pocket, Purple Hope No. 4, collected July 2013. Jeff Scovil photo.**

Figure 13 (below). **The Lightbulbs, amethyst scepters, specimen 11.5 × 12 cm, Rolling Thunder Pocket, Purple Hope No. 4, collected July 2013. Jeff Scovil photo.**

Reichenstein-Grieserntal Twins at Green Ridge

Figure 14. **Side-by-side comparison, *(left)* Japan-law twin 11.5 cm, *(right)* Reichenstein-Greiserntal-law twin (Greiserntal-law form) 15.5 cm. Jeff Scovil photos.**

REICHENSTEIN-GRIESERNTAL twins are exceptionally rare quartz contact twins that have been found at a few King County localities. Although much less common than Japan-law twins, in four seasons of mining operations we have recovered seven of the Grieserntal form and two Reichenstein twins at the Purple Hope claims. Wherever they have been found, Reichenstein-Grieserntal twins typically occur with Japan-law twins (Morgan 2014).

Reichenstein twins with the *c*-axes inclined at 103° 34′ were first defined by Rose (1851) based on examples found near Reichenstein, Saxony, Germany (now Zloty Stok, Poland). There was debate among crystallographers at the time whether these were really twins or oriented overgrowths on calcite crystals. The Grieserntal twin law with *c*-axes inclined at 76°26′ was later described by Victor Goldschmidt (1905) from a single specimen found in the Goscheneralp, Switzerland. His finding also confirmed the existence of Reichenstein twins. Goldschmidt hyphenated the name Reichenstein-Grieserntal because the complementary angles of the forms demonstrated that they were the same twin law

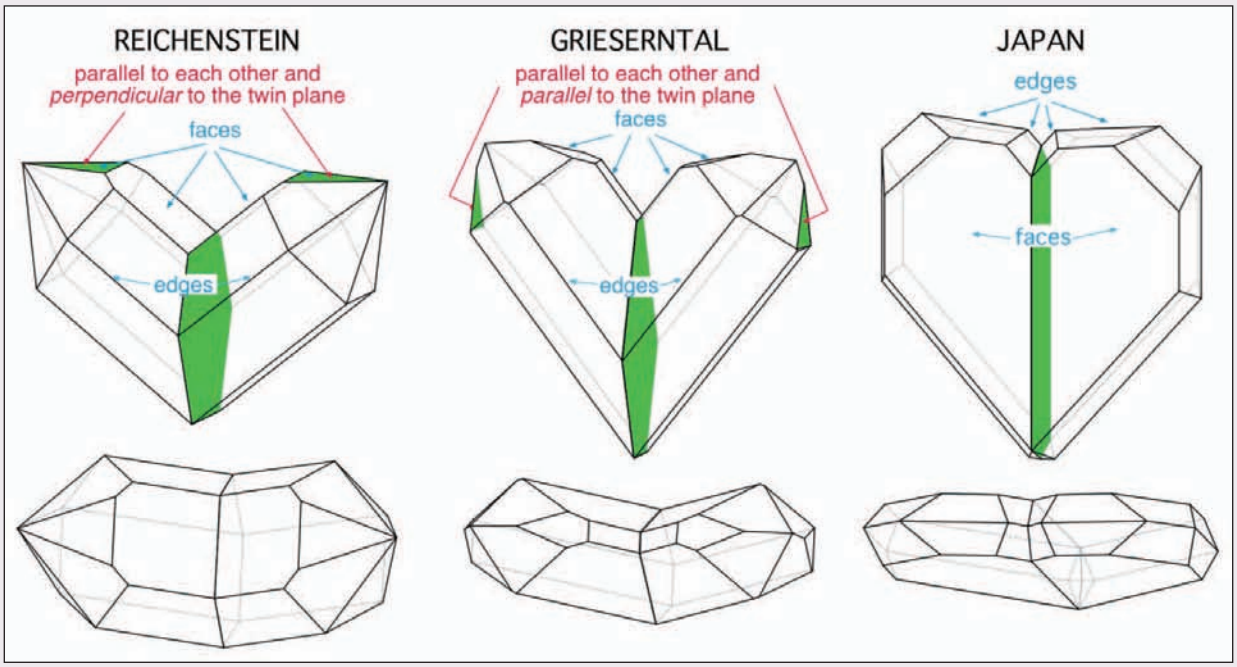


Figure 15. **Form comparisons of idealized Reichenstein-Greiserntal-law and Japan-law twins. Drawings by Dr. Peter Richards.**

(continued)

Reichenstein-Grieserntal Twins at Green Ridge *(continued)*

but joined on different composition planes. Both forms are illustrated in volume 7 of Goldschmidt's *Atlas der Krystallformen* (Goldschmidt 1922, table 72, figs. 307, 308; table 102, fig. 765). Reichenstein-Grieserntal twins are sometimes incorrectly referred to as Esterel-law twins based on examples found in the Esterel Mountains of France. However, the Esterel twin law is only properly applied to β-quartz examples (Frondel 1962).

At first glance, Japan-law twins could be confused with the Grieserntal twin form. Figure 14 is an example with the Japan-law twin on the right and the Grieserntal on the left. It might seem that the difference in the twin angle should be apparent. The *c*-axes of Japan-law twins are inclined to each other 84°33′, whereas the individual crystals comprising Grieserntal twins are inclined 76°26′. In reality, given the differences in crystal development during growth, it isn't possible to visually distinguish an 8° difference without careful measurements that most collectors are not equipped to make. There are still reliable ways to tell them apart. Figure 15 shows sketches of idealized Japan-law and Reichenstein-Grieserntal twins that illustrate the differences. The reentrant angle of a Japan-law twin is formed by the edges between pairs of two, usually narrow faces, and if you were to lay the twin down, it would rest on flat, often coplanar crystal faces. In the case of Reichenstein-Grieserntal twins, the reentrant is formed by prism faces, typically the narrowest in the case of Grieserntals or the widest in the case of Reichenstein twins. If you were to lay them down, they would rest on the edges where two prism faces meet. Besides the difference in the reentrant angle, Reichenstein twins are readily distinguished from Grieserntals by the position of the *r* face (Drugman 1911). The *r* faces of a Reichenstein twin are perpendicular to the twin composition plane; the *r* faces of Grieserntal twins are parallel to the twin composition plane. There is also a consistent difference in the shape of the crystals in our experience. The individual crystals that form a Grieserntal twin are typically coffin shaped when viewed perpendicular to the *c*-axes with the narrowest faces meeting to form the reentrant angle. The individual crystals that form a Reichenstein twin usually form a simple hexagon prism with the widest faces forming the reentrant. There has been speculation that exaggerated growth in the notch adjacent to the different composition planes results in the different shapes of the crystals forming the two twin types (Morgan 2015). ❑

the sericite to support formed a big pile in the center of the pocket, with thin layers of red clay that mostly protected them from damage. Sharp, angular breccia blocks were cemented in place by an uncharacteristic druse of tiny quartz needles on the walls, along with occasional small tabular white barite crystals. The pocket was collected within two hours, reaching a size of only some 60 cm. Two extremely fine matrix specimens were found at the back along the roof: the "Thunderbolt" (fig. 12) and the "Lightbulbs" (fig. 13). There has been some debate as to which is the better piece, but most votes are for the Thunderbolt. Even the second-tier pieces from this pocket were better than almost anything we had seen before (figs. 2 and 16).

A week later a 3-meter, vertically oriented pocket was discovered just west of the Rolling Thunder Pocket. At first the pocket was only large enough to fit a body in sideways, in one of the most-awkward-possible collecting positions, lying on one shoulder, pulling small bits of dirt and crystal down onto the collector's face. After collecting the first meter, a small controlled blast relieved a choke point. With a minimal charge, the rock had fractured enough to work some more solid granite away from where the pocket was thought to continue behind the wall. A few hours of pounding with heavy sledge hammers produced a long thin fissure and loosened a large plate from the right-hand wall. The initial plate of crystals was almost a meter tall and continued into the pocket half a meter, with 10 cm of solid wall rock attached. The biggest thrill came once George could crawl all the way into the pocket and look up. A stately crown of royal-purple amethyst scepters was hanging from the ceiling behind a large isolated

Figure 16. **Amethyst scepter, specimen 6.5 × 13 cm, Rolling Thunder Pocket, Purple Hope No. 4, collected July 2013. Jeff Scovil photo.**

Figure 17 (left). **The Crown in situ, amethyst scepters to 6 cm, Purple Reign Pocket, Purple Hope No. 4, July 2013. Joe George photo.**

Figure 18 (right). **The Crown after cleaning and trimming, specimen 7.5 × 18 cm, Purple Reign Pocket, Purple Hope No. 4, collected July 2013. Jeff Scovil photo.**

scepter (figs. 17 and 18). A Japan-law twin stood in attendance. We felt like we had entered the royal chamber. The Purple Reign Pocket was christened.

Family obligations had prevented Dillhoff from participating up until this point, and hearing what was being found left him chomping at the bit. When word came that there were so many specimens that wrapping material was running out and the miners were in a second great amethyst pocket, he arranged to fly in with a load of packing material, and we extended the project a few more days to carefully remove the Crown from the Purple Reign Pocket. While George worked at freeing the huge ceiling plate, Dillhoff started mucking an area that had already been collected, and in a tight corner he opened a small hole with large quartz grains in the loose debris inside. After additional work it was clear a large quartz seam dove under one of the big blocks. After an hour of chiseling he was able to start fishing out quartz plates and soon encountered a cluster of large amethyst scepter heads, up to the size of chicken eggs. We had a third exceptional amethyst pocket! At that point McGill was feeling left out and started scaling the wall between the two pockets. After removing a few rocks he opened a small pocket and then started howling with laughter. He reached in and pulled out the best Japan-law twin found in the 2013 season (figs. 19 and 20). Each of us was sitting in front of our own pocket with amazing specimens in hand—truly, a day to remember.

It took three of us taking turns for two days to collect the main chamber of the Purple Mountain Majesty vug. Joe collected the best plate near the end of the first day, a ceiling plate 9 × 14 cm in size with an 8-cm-long, well-colored scep-

Figure 19 (left). **Archer McGill holding freshly collected 12-cm Japan-law twin, Purple Hope No. 4, July 2013, Rick Dillhoff photo.**

Figure 20 (below). **Japan-law twin from figure 19 after cleaning, specimen 7.5 × 12.5 cm, July 2013, Purple Hope No. 4. Jeff Scovil photo.**

ter with an egg-sized head 4.5 cm in width (fig. 21) that he christened the Emperor (because we already had a king and queen). Dillhoff collected another, larger ceiling plate with amethyst on matrix right behind it. Ceiling plates were not common in this pocket. The bulk of the amethyst was in the form of fat singles and clusters, from 6 to 12 cm in length, that were loose in the pocket debris of the floor. There were at least a dozen high-quality singles and clusters. We collected 3 meters of pocket and near the end employed a modified ski pole to rake out the last specimens. A cluster of two large goethite-after-pyrite octahedra approximately the size of a loaf of bread had grown on the floor. Although they were unsalvageable, they contained brilliant corroded pyrite cores, collected as a 16 × 23-cm specimen. As icing on the cake, McGill recovered a 7-cm Japan-law twin and a 6.5-cm barite flag perched on a small quartz cluster in a chamber extending from the front of the pocket. What a way to end the season!

Figure 21. **The Emperor, amethyst scepter, specimen 6 × 14 cm, Purple Mountain Majesty Pocket, Purple Hope No. 4, collected July 2013. Jeff Scovil photo.**

In 2014 we acquired a second drill that substantially increased our ability to move rock. We concentrated exclusively on the main face bench and used the added firepower to attack a large barren area that was in the way. The crew became grumpy while we mined through a large block of barren granite devoid of pockets. Unfortunately, after four weeks of mining we were even grumpier. The block seemed to go on forever. Although a few large pockets were encountered, they contained average-quality quartz. The smaller pockets produced the most interesting specimens found in 2014.

After moving the rock below the Purple Mountain Majesty Pocket from the year before, we encountered our third sericite-lined pocket, the Lollipocket. It had an unusual architecture for Green Ridge—a series of flat-lying chambers, the largest of which measured approximately 0.5 × 1 meter but averaged only a few centimeters in height. As with the other sericite-lined vugs, the amethyst in the pocket was very bright, but unfortunately most of the big crystals were contacted because of the narrow open spaces. There was one good open lobe that produced our best amethyst matrix

Figure 22. **Ouroboros, amethyst scepters, 6 × 6-cm ring, Lollipocket, Purple Hope No. 4, collected July 2014. Rick Dillhoff photo.**

specimen of 2014 (fig. 22). George named it Ouroboros after the mythical symbol of a snake forming a circle with its tail in its mouth. A circle of scepters, each head overlapping the base of the adjacent crystal, forms the crystalline version.

There were other bright spots to the 2014 season. Only a few well-formed barite specimens have been found at Green Ridge; this season's specimen was pale blue! Barite at other Middle Fork localities can range from white to pale yellow but never blue. We found several Japan-law twins, the most interesting being a 6-cm pale smoky twin on an 11-cm pale amethyst plate. Three promising partially sceptered Japan-law twins with amethyst-sceptered tips were found, but none were perfect and complete. The perfect amethyst-sceptered Japan-law twin on matrix remains our holy grail.

The last blast of the 2014 season finally broke through the barren gray granodiorite block at the furthest end, and we were back into more altered rock. A small pocket produced a consolation twin, only 5 cm tall but phantomed by sparkly sulfide inclusions (fig. 23). A few of the clusters from this pocket have the same inclusions. We often see presumed pyrite inclusions, typically filling fractures in the quartz,

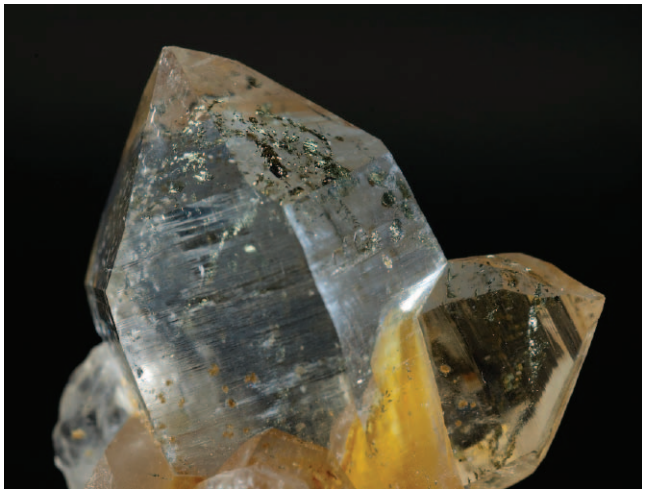


Figure 23. **Sulfide-included Japan-law twin, 3 × 3.5 cm, Purple Hope No. 4, collected September 2014. Rick Dillhoff photo.**

Figure 24. **String of Pearls Pocket zone with Joe George emerging from the entrance to the Captain Nemo Pocket, Purple Hope No. 4. Ian Merkel photo.**

some with well-formed faces. The sulfide inclusions from this pocket are vermiform bright sulfides that can't be identified by sight alone. While George collected the pocket, an ice storm dictated the end of the season; the rest of the pocket would have to wait for spring.

2015: The Purple Sea

Despite the disappointments of the 2014 season, we planned to double our mining days in 2015 and break them into three sessions, hoping to find a big pocket under that barren block we mined in 2014. To our dismay, the inclusion pocket pinched closed after only a meter or so, and only simple quartz crystals were found after that. No scepters and no more twins! More blasts revealed a string of closely related pockets in the altered rock just to the right of the big block. After opening the third pocket, we started calling the zone the String of Pearls. The largest pocket, Moby Dick, was a lens almost 3 meters in length alongside the edge of the block. Late on our last collecting day of the first mining session Dillhoff and George took turns fishing pieces out of Moby. Dillhoff collected a 7-cm twin ear out of the pocket and then turned collecting over to George who promptly found the second ear—it repaired nicely into an "R-J" (Rick-Joe) twin.

The most notable feature of this huge pocket was the long, flat ceiling that lined up with the rest of the pockets in the String of Pearls. Two pockets to the right we encountered the Black Pearl Pocket, noteworthy for its complete lack of quartz and filled with only a crisp, frothy mass of iron oxides. We had never seen a pocket large enough to crawl into that had virtually no quartz crystals in it. A meter to the right of the Black Pearl, another nearly crawl-in-sized pocket yielded some pale amethyst and a little bit of the scepter growth we had been hoping for. Our first session ended optimistically, but our best efforts had not even recouped mining expenses since 2013. By now the String of Pearls stretched over approximately 5 meters (fig. 24).

At the beginning of the second session of the 2015 season, things started to look up. After the first blast, McGill opened the Mother Earth Pocket that produced two of the most classic long-stemmed amethyst scepters we have found, "Big" and "Little Brother" (figs. 25 and 26). However, the pocket produced only a few pieces, and the following blasts were disappointing. The String of Pearls seemed to be played out, and we were still mired in remnants of the big barren block. It was time to try something new. The decision was made to refocus our efforts on developing a new cut into the cliff above in order to get deeper into the rock, beginning at the east end of the bench and hopefully to cut back down through the previous productive zones.

McGill opened the first significant pocket and named it Twin Fantasy after pulling out a 14-cm Japan-law twin with one huge, dramatically sceptered ear. The crystals all had superb luster; however, the internal clarity was compromised by fractures. The size of the crystals and presence of twins kept the fantasy alive. George named his first pocket on the new bench the Yoga Pocket, as he had to bend sideways with

arched back into extreme positions while suspended from rope to enter the pocket, and then use previously unknown core muscles to shimmy into and around the corner of the entrance. It was getting late, McGill went back to camp. Collecting on rope in ridiculously bent positions after a hard day of drilling and mucking got to be too much for George, but he wasn't ready to call it a day. There was a nice flat bench under the String of Pearls, so he decided to poke around there once more before joining McGill. A half-hour before sunset, the jumbled crust and granite between Moby Dick and the Black Pearl gave way. Large quartz plates to 30 cm across began to come from a new man-sized opening! A plate jammed in the pocket a meter up from the entrance was turned over to reveal a large Japan-law twin, and the call of celebration ended the day's collecting. Filling a pack was easy as the last light of the day glowed behind the mountain silhouettes.

George and McGill climbed back up to the new pocket with excitement the next morning. After a couple of hours of chiseling, the hole was large enough to fit George's upper body. Working his way up the tube he felt like the submariner Captain Nemo, sneaking up on his quarry from the inky deep. His entry was blocked by a big plate in the ceiling; he wiggled it loose, and it fell on his head. Similar to the effect of opening a submarine hatch a little too soon, the contents of the pocket poured in on top of George. Hearing the muffled exclamation, "It's on my head," McGill ran over to assist in the extraction of George and the large plate. As he wriggled back down out of the manhole, the contents of the pocket sluiced dirt and crystals out onto the bench below. The large plate that had ended up on top of George's head showed several amethyst scepters on matrix! Captain Nemo was no small pocket. When George shimmied back up he could see 3 meters of open air space widening toward the top! Most of the ceiling had weathered and fallen into the middle of the pocket, leaving a large pile of crystals and matrix specimens precariously stacked in the center of the pocket. Some matrix plates were huge (fig. 27). Every crystal miner's dream is to crawl around in a lantern-lit pocket with a buddy and be dazzled by spectacular works of nature. The dream had come true, but it was time to get to work.

The complicated jigsaw puzzle of sharp crystalline fragments was going to be a challenge to disassemble without causing any further damage. Even though the pocket contents were loose, it was a daunting task, given the volume of material. Amethyst crystals in the top layer had clearly fallen from the ceiling. Nearing the floor, we encountered a layer of corroded pyrite and hard goethite crust, underneath which was another layer of plates—all with their tips pointing downward. This pocket had clearly undergone several generations of growth and breakdown during formation. Although multiple collapses had done some damage, the amethyst was the last generation and at least fell on top of the pile. A number of pristine "flowers" of large amethyst crystals were recovered, despite falling more than a meter from the roof eons ago. After several days of collecting we had to shut down operations and fly out our specimens to see what we really had. George was preparing for the Denver

Figure 25 (left). **Big Brother, amethyst scepter, specimen 9 × 9.5 cm, Mother Earth Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

Figure 26 (above). **Little Brother, amethyst scepter, 2.5 × 6 cm, Mother Earth Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

Figure 27. **Joe George mucking out the Captain Nemo Pocket, September 2015. Rick Dillhoff photo.**

Figure 28. **Doubly terminated amethyst, specimen 6 × 9.5 cm, Captain Nemo Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

Figure 31. **Amethyst scepters, specimen 10 × 10 cm, Captain Nemo Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

Gem and Mineral Show, and we would not be able to finish the pocket until after the show.

Captain Nemo ultimately consisted of a 3-meter vertical entrance with a large open chamber at the top intersecting a horizontal tube open for 2 meters to the right and 5 meters to the left, about 10 meters of pocket in all! The left chamber continued all the way behind the large barren block we had blasted the entire 2014 season. This pocket contained the largest quantity of amethyst we have seen in any Green Ridge pocket. The best amethyst specimens ranged from a 20-cm plate to spectacular singles. There were even a couple of doubly terminated crystals, amethystine at both ends (fig. 28). Figures 28–32 include a sampling of the very best amethysts from the pocket. Besides amethyst, in a side chamber McGill collected the two best barites we've found at Green Ridge, including an 8-cm barite flower on a 10-cm quartz plate. Huge,

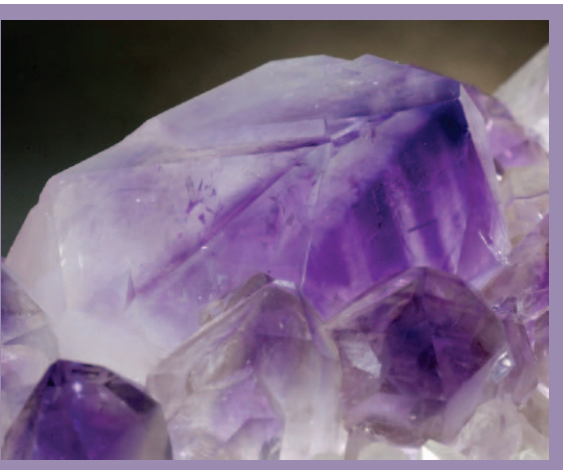


Figure 29 (left). **Amethyst scepters, specimen 9 × 16 cm, Captain Nemo Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

Figure 30 (right). **Color zoning in the central crystal from figure 29, Captain Nemo Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

Figure 32. **Amethyst scepters, specimen 11 × 14.5 cm, Captain Nemo Pocket, Purple Hope No. 4, collected July 2015. Rick Dillhoff photo.**

heavily corroded pyrite octahedra to 18 cm on edge grew in the limonite crust of the floor of the barite chamber. Our only disappointment was that there wasn't a good Japan-law twin to top off the pocket.

Our final session of 2015 turned out to be a challenge. George and McGill worked to open Captain Nemo so we could reach the back, but it meant starting high above the pocket on a nearly vertical face. As George was drilling the last shot to open the entrance, a substantial rock fell from above and hit him in the knee. The wound wasn't large, but bone was visible. This could not be good. Dillhoff got the call, our faithful helicopter pilot Tony Reese was there an hour later, and George was in the emergency room within a couple hours following the accident. After a couple of days recuperating, George was chomping at the bit to get back, and Dillhoff went along, promising George's wife to keep him from tearing out his stitches. On arrival, George donned a harness and climbed the wall to scale all the loose rock from the spot where the rock that hit him had fallen. So much for promises, but George was determined there would be no more surprise visitors from above. Dillhoff and McGill did at least convince George he wasn't allowed to drill. McGill had constructed a ladder to help with access for George and Dillhoff (fig. 33). Digging in the floor, Dillhoff encountered a ledge blocking access to a widening chamber, so he tried to chisel it off. When it proved to be stubborn, he felt to see what might be on the bottom before he took a sledgehammer to it. That turned out to be a good thing. There was a 6-cm Japan-law twin hanging on the edge of the plate. After two hours of effort Dillhoff broke loose a 30-kilogram plate. The first challenge was preventing it from falling to the bottom of a steep chute; the next was flipping it over to protect the Japan-law twin. McGill got the call again. Instead of "it's on my head" he heard "help me with this twin!" We finally lowered it to the bench as the sun got low in the sky (fig. 34). It is an usually brilliant twin for Green Ridge, and the plate includes an interesting pyrite (fig. 35). It was the perfect end to another great season, or so we thought.

Figure 33. **Joe George entering the Captain Nemo Pocket, September 2015, Purple Hope No. 4. Rick Dillhoff photo.**

We had a stretch of good fall weather, and after a couple weeks of recuperation, George couldn't take sitting at home. Besides, we needed to disassemble our temporary structure before the snow season. Upon arrival George immediately headed for the work face and Captain Nemo. He soon located the "Blowhole" extension, going straight up into the ceiling from Captain Nemo, with another batch of good amethysts, including an exceptional 10.5-cm long-stemmed scepter and another that showed incredible color zoning. When he finished the extension, George began thinking about unfinished business—there was that fissure in the back of the Yoga Pocket he had given up on the day he stumbled into Nemo. Back in the harness, he finally broke through into a new chamber. He could see open space but had no dynamite. He tracked down the seldom-used jackhammer attachment for the trusty Cobra drill and hammered an opening he could barely squeeze into.

Figure 34 (above). **Japan-law twin, 5 × 6.5 cm, Captain Nemo Pocket, Purple Hope No. 4, collected September 2015. Rick Dillhoff photo.**

Figure 35 (below). **Japan-law twin and pyrite, specimen 15 × 19 cm, Purple Hope No. 4, collected September 2015. Rick Dillhoff photo.**

The Never Surrender Pocket is 3 meters long, ending in a pool of water, a rarity at Green Ridge. The best crystals from this pocket are lightly amethystine, exceptionally brilliant, and huge. After trimming, the "Crystal Mountain" is a 31-cm matrix specimen with five major crystals to 11 cm long. With that beast on his back, there were hard decisions to be made about what else George could carry down, but he made room for a plate with an oddly shaped quartz sticking out of a mass of limonite. It turned out to be the second best Reichenstein-Greiserntal-law twin found at Green Ridge. The pocket even contained a long-sought amethyst-sceptered twin on matrix, but the twin is a little too hidden to achieve perfection. We're holding out for one that stands up proudly and dares you to miss it . . . maybe next year.

The Minerals

The list of display-quality minerals from Green Ridge is short: barite, pyrite, and quartz. Identification of the known inclusions would extend the list, but that work remains to be done.

Figure 36. **Barite on quartz, 5.5 × 6 cm, Nacho Bench, Purple Hope No. 4, collected 2002. Jeff Scovil photo.**

Barite

Barite is fairly common as small (less than 1-cm) white blades that are often overlooked and not of specimen quality. In the sericite-lined pockets it sometimes is found with tiny quartz crystals cementing the breccia fragments, so its formation is clearly late stage. Specimen-quality barite is very rare—up to 2012 the only one found had come from George's earliest digging on the Nacho Bench (fig. 36). With

Figure 37. **Barite on quartz, 3 × 5 cm, Purple Hope No. 2, collected August 2012. Jeff Scovil photo.**

Figure 38. **Barite on quartz, 7 × 10.5 cm, Captain Nemo Pocket, Purple Hope No. 4, July 2015. Rick Dillhoff photo.**

the increased mining during the past four years, at least one aesthetic barite crystal cluster has been found each season, the largest consisting of two crystals, 10.5 cm in length. The color is generally creamy white, but a pocket in 2014 produced the first pale blue specimen. Good barite has also been found at Purple Hope No. 2 (fig. 37). During the 2015 season Captain Nemo produced two exceptional clusters, the best on matrix (fig. 38).

Pyrite

The remnants of octahedral pyrite crystals are commonly encountered and can range to 20 cm on edge for a single crystal. Typically, a thick goethite shell remains in the original crystal form but falls apart at the slightest touch or at any exposure to water. When intact limonite is breached, a greasy fluid escapes, which we suspect is a weak sulfuric acid solution. Inside the hollow shell we find brilliant pyrite pieces, best described as "worm-eaten." Some show the outline of the original crystal form, typically sharp octahedral, but the original faces are long gone, sometimes replaced with a granular texture, as in figure 35. Cubic forms are much less common although one of the few specimens showing the original faces is a cube from Purple Hope No. 2 (fig. 39). Figure 40 is a complex crystal form retaining its bright faces, but most are artful remnants, as shown in figure 41. Crusts of yellow microcrystals are occasionally found on the corroded pyrite surfaces. We are hopeful that unaltered pyrite may become more common as we work back into unweathered rock. Presumed pyrite is also common as inclusions and fracture fillings in quartz crystals, but the sulfide inclusions have not yet been positively identified.

Quartz

Quartz occurs at Green Ridge in almost every form except Gwindels (we're still looking). Although crystals are typically white or colorless, amethyst, pale citrine, and pale smoky quartz crystals are also found. The amethyst is of-

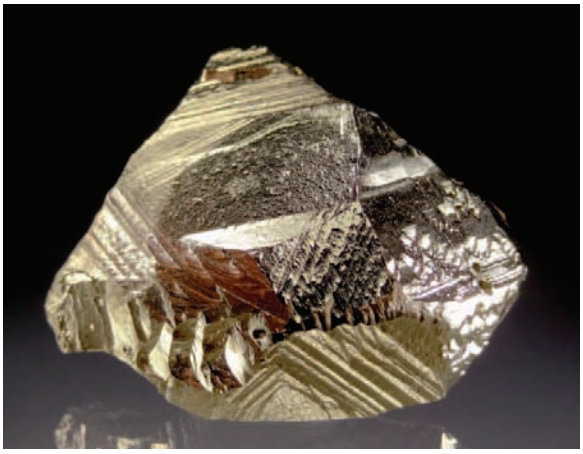


Figure 39 (left). **Pyrite, 3 × 3 cm, Purple Hope No. 2, collected August 2012. Rick Dillhoff photo.**

Figure 40 (below left). **Pyrite, 4 × 5 cm, Ballroom Pocket, Purple Hope No. 4, collected July 2014. Joe George photo.**

Figure 41 (below). **The Snapping Turtle, pyrite, 2 × 2 cm, Purple Hope No. 4, collected July 2014. Joe George photo.**

Figure 42 (above). **Amethyst zoning, field of view 6 × 6 cm, Captain Nemo Pocket, Blowhole extension, Purple Hope No. 4, collected October 2015. Joe George photo.**

Figure 43 (right). **Citrine, 2.5 × 10.5 cm, Purple Hope No. 4, collected August 2015. Joe George photo.**

ten distinctively zoned, and alternating layers of purple and clear quartz parallel to the termination faces of the crystal are commonly visible. In most cases the amethyst zones are much darker on one side of the crystal axes and are clear or pale on the other side, resulting in a "half-and-half" specimen (fig. 42). Amethyst in surface pockets is typically pale, but as we penetrate deeper into the rock the color equals the darkest amethyst found in King County. Citrine is usually diffused throughout, or occasionally a citrine core forms phantoms in quartz (fig. 43). Smoky coloration is generally present as zoning, often with a seeming relationship to external crystal faces rather than the crystal axes.

Many of the plates of clear quartz detached from the matrix at some point in pocket evolution, and the backs of the plates proceeded to grow, creating plates terminated on both sides. Occasionally druses of amethyst occur, but the exceptional specimens are late-stage scepters that have much higher clarity and luster than the underlying quartz matrix. They often contain liquid inclusions, rarely with a gas bubble. Besides the scepters, twins are the most sought form of quartz at Green Ridge. Brilliant Japan-law twins are not common, but almost every major pocket will contain one or two twins. A wide variety of Japan-law twin forms are present, some reaching 15 cm across. A "Madagascar" form Japan-law twin found in 2015 is Dillhoff's personal favorite (fig. 44). Much rarer but practically common in comparison to worldwide occurrences, Reichenstein-Grieserntal-law twins have also been found (see sidebar, p. 506). We have found nine in the last three seasons, seven of the Grieserntal form and two of the Reichenstein (one of which unfortunately disintegrated during cleaning).

Conclusion

We started with a shared belief that Green Ridge might produce some of the best quartz found in King County. Realizing the potential of the Purple Hope claims has been a dream come true. It is the culmination of decades of collecting and four mining seasons of investment and hard work. The Purple Hope claims are now located within the boundaries of the Alpine Lakes Wilderness area, and collecting outside the claim boundaries within the wilderness is prohibited by federal regulation. We do not grant permission to collect on our claims. Please respect the wilderness and our hard work. We still need to find that amethyst-sceptered Japan-law twin we've been dreaming about.

Figure 44. **Japan-law twin (Madagascar form), specimen 3.5 × 8 cm, Purple Hope No. 4, collected June 2015. Rick Dillhoff photo.**

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