Major Crocoite Discoveries

at the Adelaide Mine, Tasmania

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In August 2012 an extraordinary watercourse pocket of crocoite crystals was discovered at the famous Adelaide mine near Zeehan, Tasmania—the most recent in a long but intermittent history of such discoveries dating back to the 1890s. Collecting of specimens from the watercourse began in early September; as of this writing, the full extent of the pocket has yet to be determined.

INTRODUCTION

Mineral collectors have always held crocoite in high esteem. The appeal of the lead chromate comes mainly from its vivid red-orange color and (in well-prepared specimens) its high luster. And maybe a little charisma comes also from the extreme delicacy of the specimens, which typically are masses of stiff, stalk-like crystals attached to each other by small amounts of earthy brown and black oxide material. Then there is the allure of the fact that nearly all market-available crocoite specimens are from Tasmania, the most remote and exotic-sounding of Australian states and, it's easy to think, very far from *anywhere* else.

One often thinks of Tasmania in just that way, even after having visited there—it *is* remote and exotic. But a visit is not only survivable, it is fully enjoyable; Tasmanians are quite civilized, hospitable and good-humored, and yes, even English-speaking (albeit in accents that can bemuse people from "the mainland," as they call all the rest of Australia). Tasmania is also very beautiful, with a wide-open, green, dreamy countryside marked by stout eucalyptus and oaks and dense fern forests; and for the most part these big-sky slabs of landscape remain unspoiled by the works of man.

One of us (TPM) was fortunate enough to visit Tasmania recently to view the new crocoite discovery *in situ*: Crouching in a tight, muddy drift of the Adelaide lead-silver mine, 10 kilometers east of the town of Zeehan near the western coast of the island, one could stare far, far back down the length of a watercourse pocket, the walls of which were covered by brilliant red, splint-like, gleaming-wet crocoite crystals. This new "Red River Find" (as it has been dubbed by Adam Wright) proved to be dramatic indeed.

THE DUNDAS MINERAL FIELD

Crocoite was described as a species in 1764, from type material which came from the Tsvetnoi mine, one of the gold mines of the Berezovsk district in Russia. Even in recent years, small lots of Russian crocoite, some of it newly collected (!), have surfaced (Cooper, 1994; Moore, 1995), but these Russian "locality" items do not come close to rivaling the best Tasmanian crocoites, all of which have emerged from the old lead-silver mines of the Dundas mineral field near Zeehan. These mines were active during the 1880s and 1890s, but by the time of World War I nearly all of them had failed as ore producers and had been closed down. But intermittent specimen-mining, especially since about 1970, has kept the crocoite magic alive.

Most late 20th-century crocoite specimens have been taken from the Red Lead and Adelaide mines, whose entrances lie only 900 meters apart, on different slopes of a rise called Stichtite Hill. Both mines have seen major pocket discoveries, but the pocket found in 2012 might well turn out to be greatest of all. It was breached in mid-year by The Adelaide Mining Company Pty. Ltd., the current

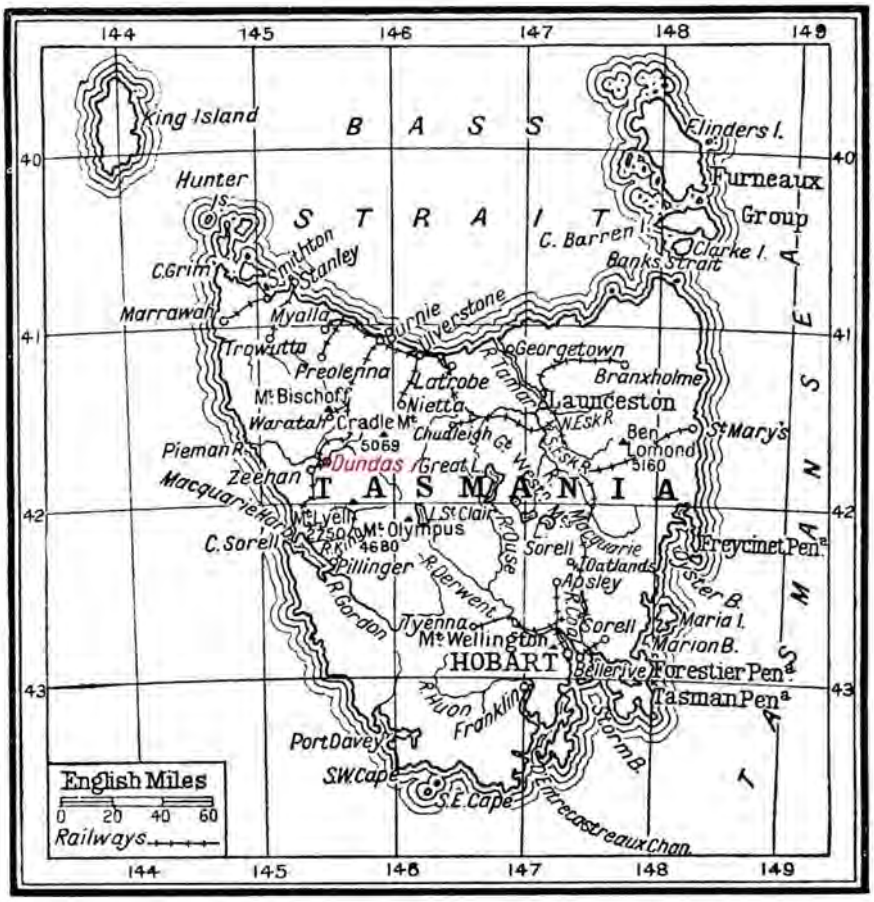


Figure 1. **Location map. (The Probert Encyclopedia, 1938).**

lessee of the Adelaide mine, and as of this writing in August 2012, exploration of and collecting from the new find is proceeding apace, and the end of the watercourse has not yet come into view. A DVD expertly fashioned by Bryan Swoboda of *BlueCap Productions*, enclosed with this issue of the *Mineralogical Record*, is an effort to preserve a record of the great pocket; this article is another.

EARLY HISTORY

The first European eyes to rest on Tasmania belonged to someone aboard a vessel commanded by Dutch navigator Abel Janszoon Tasman, in 1642. After dropping anchor briefly on the western coast not far south of present-day Zeehan, and after gathering biological samples including intriguing cuboid specimens of wombat feces, Tasman's ship left again and sailed on to discover New Zealand. Desultory British and French explorations followed, but nothing of a "colonial" nature occurred until 1802, when a British ship, in order to forestall French plans of settlement, came down from New South Wales to claim "Van Diemen's Land" (as the British then called Tasmania) for the Crown (Stewart and Daly, 2008). The island was officially renamed Tasmania in 1856, after being granted self-government.

In 1803 a British party of 49 would-be settlers, including 24 convicts, arrived in Tasmania, and 240 more convicts were deposited at the site of present-day Hobart in 1804. In 1822 the first European settlement in western Tasmania took the form of a penal colony set up on Sarah Island in Macquarie Harbor. This prison camp, plus two more established later, served as dumping grounds for the worst convicts from mainland Australia and from the mother country, and did so until 1873, when the last prisoner left the island. This history gave rise to the term "bushwalking," which means wandering through Tasmanian forests until dehydration and starvation bring on death: ironically used, the term refers to the situation of innocent hikers, but it is rooted in memories of what always happened to convicts foolhardy enough to escape from the Tasmanian prison camps.

When a prospector named James "Philosopher" Smith found a large, rich deposit of tin at Mt. Bischoff in 1871, major exploitation of Tasmanian mineral resources was catalyzed. The Mt. Bischoff tin mine at Waratah, about 50 km north of the Dundas field, had become the richest tin mine in the world by the 1880s, and mining there did not stop until the 1940s (Haupt, 1988; Bottrill and Baker, 2008). During the later 1870s and into the 1880s, numerous other mines for tin, copper, gold and silver were inaugurated in Tasmania, especially in its western sector, and in the mid-1880s the lead-silver deposits of what would be the Zeehan and Dundas mineral fields were discovered. According to Bottrill and Baker (2008), the Zeehan field was discovered in 1882, when George Renison Bell found a "substantial" galena lode near the present town center of Zeehan, and rapid development of mining just east of the town commenced. Miners rushed to the area, seeking the numerous shallow, silver-rich gossans, but because of the rapid exhaustion of these deposits, and because of mining difficulties in this mostly flat, waterlogged area, prospectors gradually moved into the hillier terrain to the east. There, the Dundas field was found in about 1887 by "Comet" Johnstone, and the first lease was pegged in 1888 (Bottrill *et al*., 2006). Most of the other major deposits of the Dundas field had been discovered by 1900.

During the heyday of commercial mining, i.e. from the mid-1880s through about 1915, Zeehan was the third largest town in Tasmania, after Hobart and Launceston. Nicknamed "Silver City," it was a typical boom-and-bust mining town, with a population of 10,000 people (population in 2006: 845), a gingerbread-looking

Figures 2 and 3 (above and right). **The West Coast Pioneers' Memorial Museum in Zeehan, Tasmania. Tom Moore photos.**

opera house (the Gaiety Theater, visited by Lola Montez), 27 drinking establishments, and the Zeehan Stock Exchange. Main Street today offers tourists only a few antique but well-maintained houses, souvenir shops, and, the star of the show, the West Coast Pioneers' Memorial Museum. This excellent little museum (formerly the home of the Zeehan School of Mines and Metallurgy, 1893–1960) boasts two floors of creative displays of mining artifacts, documents, old photos, etc., and a large room full of cases displaying mineral specimens including enormous crocoite crystal groups brought out a century and more ago.

Most of the main crocoite deposits were near the town of Dundas, which in 1891 boasted a population of 1,080 and three hotels (Bottrill *et al*., 2006), but is now an overgrown field of ruins. A bumpy dirt road is all that's left to show the way to the former town center, in and around which one finds only weathered foundations of houses topped by resurgent rainforest vegetation. But after the townsite was abandoned, prospectors moved on to establish other major mines in the region, including the Renison (tin), Rosebery (silver-lead-zinc) and Mount Lyell (copper-gold) mines, all still in operation today.

GEOLOGY AND MINERALS

The mines of the Dundas mineral field lie within a four-square-kilometer area whose western border lies 1 km east of the ruins of Dundas and 10 km east of Zeehan; major workings include the Dundas Extended, Adelaide, Red Lead, Andersons, West Comet, Platt, Comet, Maestries, Kosminsky, and South Comet mines. The geology and mineralogy of the field is discussed in detail by Chapman (1972), Haupt (1988) and Bottrill *et al*. (2006), but a very brief summary is offered here.

Late Precambrian metasedimentary rocks of the Tyennan Block lie to the east of the Dundas field and crop out as an anticlinal dome in its center; slightly younger, much less altered sedimentary rocks lie to the west and south. Around the dome lie Cambrian-age intrusions of serpentinite; the chromium needed to form crocoite was derived from original magnesiochromite-chromite (locally altered to stichtite), Cr-rich spinel, and Cr-rich muscovite ("fuchsite") in the serpentinite. During the Cambrian, the serpentinite intrusions were thrust onto lightly altered marine sedimentary rocks on the west and south of the field. During the Devonian, compressional tectonic movement, accompanied by metal-rich granite intrusions, squeezed the sedimentary and metasedimentary rocks against the serpentinite masses, and faults with extensive shear zones formed, striking generally north, at the contacts. Wide bands of brecciation in the shear zones channeled metal-rich hydrothermal fluids from

Figure 4. **Exhibit of Adelaide mine specimens in the West Coast Pioneers' Memorial Museum. Tom Moore photo.**

Figure 5. **Exhibit of large crocoite specimens from the Adelaide mine in the West Coast Pioneers' Memorial Museum. Tom Moore photo.**

underlying granite, altering much serpentinite to a peculiar rock type called listwanite, composed of Ca-Mn carbonates, quartz, and fuchsite (Praszkier and Wright, 2010), and precipitating pods and veins of argentiferous galena, with minor arsenopyrite, pyrite, sphalerite and antimony sulfosalts. Finally, rapid weathering (in this very wet climate) of the near-surface veins by acidic groundwaters altered most of the sulfides to supergene minerals in a setting of ubiquitous muddy gossan containing goethite, limonite, coronadite, chalcophanite, "fuchsite," gibbsite, carbonates and halloysite clays. Profitable mining for lead and silver turned out to be short-lived because the pods and lenses of unaltered galena contained less silver than the gossans; also, the galena pods were small and erratic and the shallow ones were soon exhausted. No other veins of primary ores have been discovered at depth.

The dominance of crocoite over other secondary lead minerals in the Dundas field generally, and in the Adelaide and Red Lead mines in the southern part of the field in particular, is explained by Bottrill *et al*. (2006) as a function not only of the great abundance of chromium but also of the fact that crocoite is less soluble and more stable than most other lead minerals at the low pH levels

which generally prevail in the area; also, Cr^{6+}, the chromium valence state in crocoite, is much more mobile in fluid environments than Cr^{3+}, and so the necessary ions can travel farther and be more widely dispersed. Lead, on the other hand, is relatively immobile in groundwater and must await the arrival of other, more mobile elements with which to join in the formation of secondary minerals. As a visit to the mineral room in the West Coast Pioneers' Memorial Museum shows, crocoite was vastly more common in the Dundas field than anglesite, cerussite, mimetite, pyromorphite or phosgenite, although all of these species were found occasionally in well crystallized examples.

Beautiful bright yellow "chrome" cerussite, sought avidly by collectors, might indeed be called the only *other* signature mineral of the Dundas field. But Bottrill *et al*. (2006) cite studies suggesting that chromium may not be, after all, the source of the yellow color of this cerussite; for example, Melchiorre *et al*. (2006) suggest that the color is due to organic matter or radioactivity. However, the color has a close correlation to associated crocoite, and spectroscopic studies indicate that Cr is indeed a chromophore—the matter is under active investigation as of 2012 (Ralph Bottrill, personal communication).

Specimens showing small but bright, dark green to yellow-green crystals of pyromorphite attractively associated with red crocoite are a specialty of the Platt mine, now leased by Bruce Stark (Adam Wright of The Adelaide Mining Company has been known to bring pretty specimens of this material to the Tucson Show). Sharp, colorless and transparent to milky white, dagger-shaped crystals of anglesite reaching 3 cm came from some of the Dundas mines in the early days, and pale yellow mimetite crystals exceptionally reaching 1 cm are known as well. Very rarely, good phosgenite specimens showing sharp, grayish, translucent crystals to 2 cm were found. Masses of yellow-green to gray, modified cubic crystals of chlorargyrite to 5 mm individually are occasionally unearthed in the Adelaide mine (Bottrill *et al*., 2006). Snow-white to pale green sprays of acicular dundasite are found in some zones; these appear to alter readily to cream-white gibbsite. Lilac to purple patches of massive stichtite in serpentine are well known from several areas in the Dundas field, but not in the crocoite mines; the type locality is Stichtite Hill, uphill from the Adelaide and Red Lead mines (Bottril and Graham, 2008). The list of very rare species, seen in massive form and as microcrystals, includes three new species for which the Red Lead mine is the type locality: petterdite, philipsbornite and reynoldsite (Kampf *et al*., 2012), as well as bindheimite, hinsdalite-plumbogummite, grimaldiite, linarite and even native lead, an old sample of which from "Mt. Dundas" is largely altered today to litharge and hydrocerussite (Bottrill and Baker, 2008).

CROCOITE FROM THE DUNDAS FIELD

All relevant sources say that the first Tasmanian discovery of crocoite occurred at the Heazlewood lead-silver mine near Waratah, 50 km north of the Dundas field, but the date of the discovery is unclear. Mining records indicate that the Heazlewood deposit was found by Bell in 1884 and the lease granted in 1886. It is likely that the presence of a mineral as colorful as crocoite would have been noticed very quickly, and indeed the earliest mine-inspector reports of 1888 mention crocoite and "wulfenite" (probably yellow cerussite) (Ralph Bottrill, personal communication). William F. Petterd, the earliest summarizer of the known minerals of Tasmania, stated in his 1893 *Catalogue of minerals known to occur in Tasmania* (published in 1894) that crocoite ("crocoisite") was discovered at the Heazlewood mine "a few years back."

Haupt (1988) and Kissling (1996) believe that crocoite was first discovered at the **Adelaide mine** in 1891, the date of the earliest mining there; the 1892 edition of Dana's *System of Mineralogy* does not yet mention it, but by 1893 crocoite was well-known from the Adelaide mine; Petterd (1894) wrote:

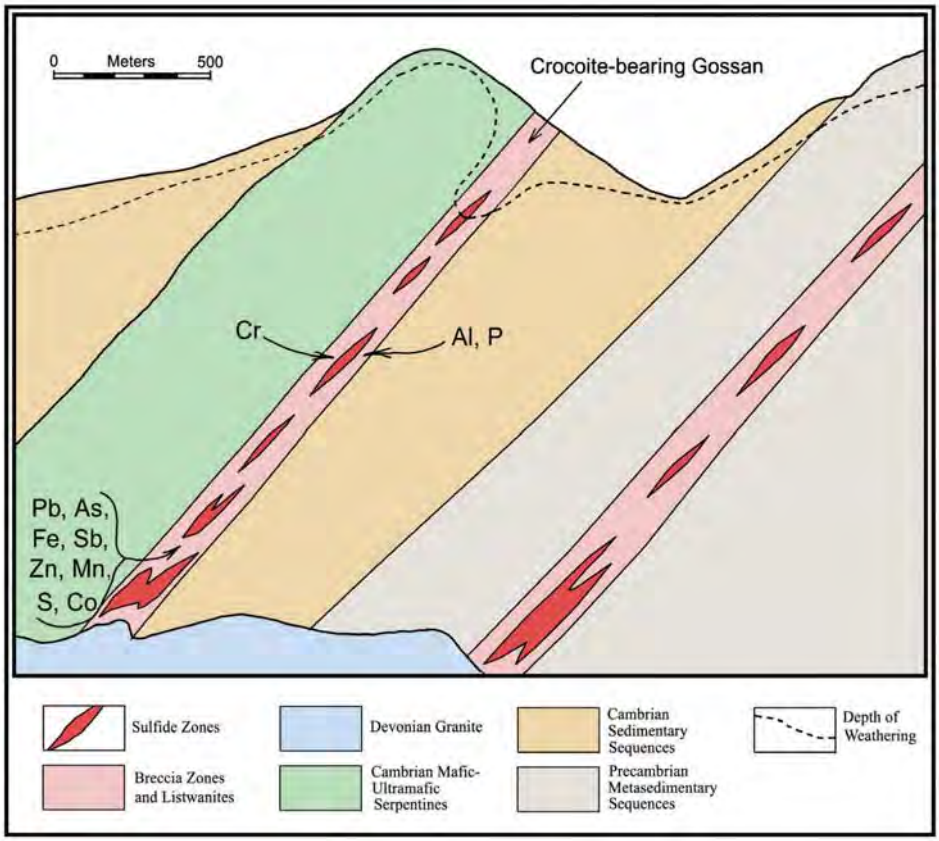


Figure 6. **Geologic cross-section through the veins of the Dundas ore field (after Bottrill and Baker, 2008). Chromium migrates into the weathering lead-rich sulfide lenses while aluminum and phosphorus migrate in from the sedimentary rocks. Weathering of the gossan zone allows these elements to combine to form secondary minerals including crocoite.**

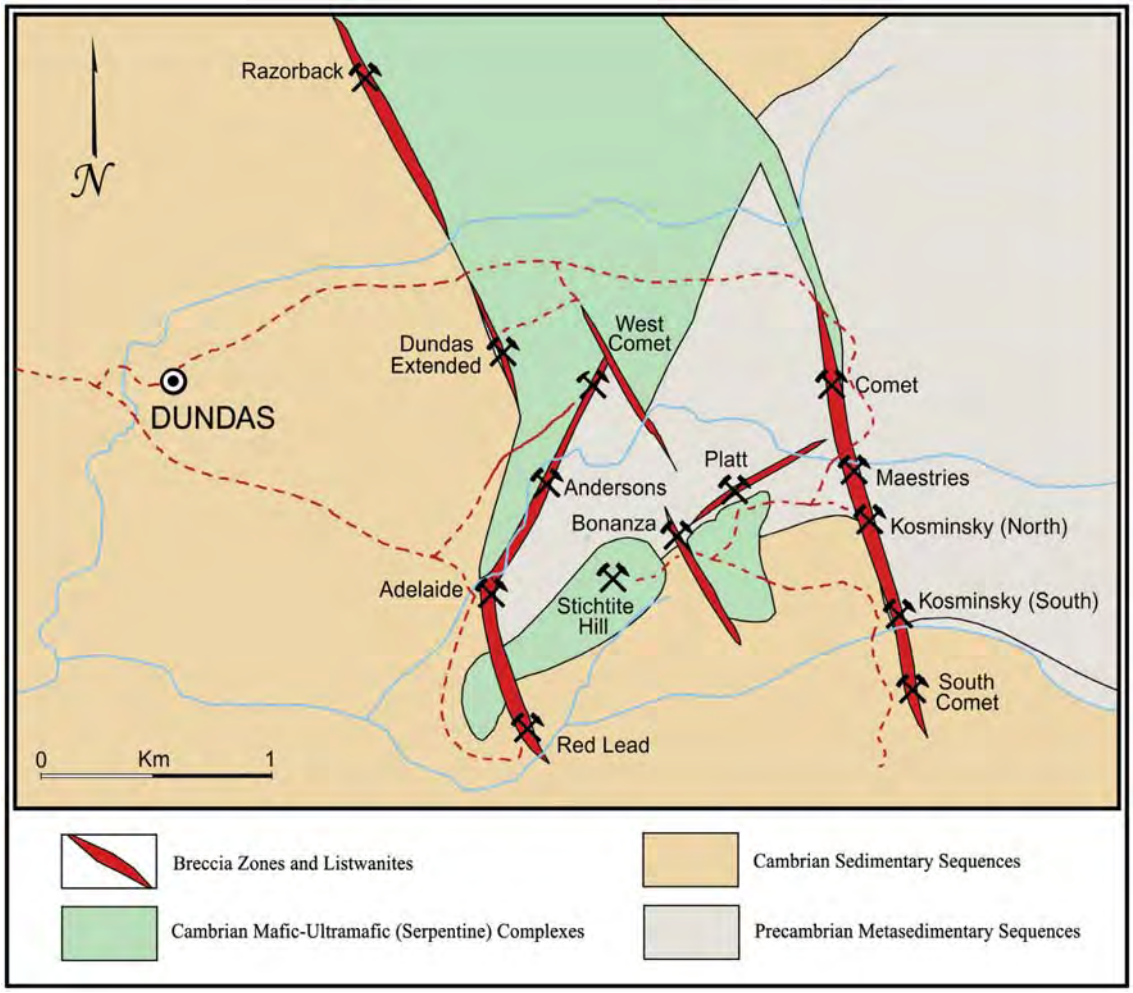


Figure 7. **Geology of the Dundas area, showing the alignment of the major mines along breccia zones that are near chromium-rich serpentine bodies (after Bottrill and Baker, 2008).**

At the Adelaide Proprietary mine at Dundas, this species is very plentiful. It commonly occurs in large columnar prisms, often several inches in length, that penetrate the vesicular ferromanganese gossan that overcaps the lode. In the workings of this mine some extremely fine and beautiful specimens have been obtained, the mineral often coating white Dundasite, and occasionally associated with crystals and large bunches of Cerussite and more rarely Anglesite.

Over the last 120 years or so the best sources of crocoite specimens in the Dundas field have been the Adelaide and the Red Lead mines, and a few others as well—although the Adelaide is probably responsible for over 90% of the crocoite specimens in collections today. The **Kapi mine** in Northeast Dundas (just off the northern edge of the map in Fig. 7) once produced attractive specimens in which bright crocoite crystals are associated with yellow cerussite and yellow phosgenite crystals; by the late 1970s this mine had "passed its zenith in specimen production" (Lancaster, 1977), although there have been sporadic recoveries of good specimens since then (Bottrill *et al*., 2006).

During the 2000s, Michael and Eleanor Phelan established a home on the old Dundas town site (Howard, 2009) while operating the **Dundas Extended mine**, where they found specimens showing "small but beautifully terminated crocoite in unusual bipyramidal forms reminiscent of some wulfenite, associated with cerussite and quartz" (Bottrill and Baker, 2008). Bottrill *et al*. (2006) remark that at Dundas Extended, crocoite crystals occur characteristically on whitish, granular, quartz-rich matrix, and some are of a distinct orange-pink hue; they add that a few specimens showing good prismatic crocoite crystals were brought out after 2000.

In the 1890s the **West Comet mine** (also called the **Mount Dundas mine** and the **Central Dundas mine**; Lieber, 1989) produced huge quantities of crocoite, reportedly including perfectly terminated crystals to 12 cm long, but a specimen-mining effort in the early 1970s was unsuccessful (Lancaster, 1977; Bottrill and Baker, 2008). A few good specimens have been recovered in recent years by John Bishop (Ralph Bottrill, personal communication).

As mentioned earlier, the **Platt mine** (or "prospect") is known for color-contrasted specimens of crocoite and pyromorphite, both species occurring as crystals which rarely reach 1 cm; the pyromorphite is apple-green to dark green, and the crocoite crystals commonly show very sharp terminations. Platt was begun as a specimen mine in 1976 by Michael Phelan and Joe Pringle (Lancaster, 1977), and is continuing so under Bruce Stark, its current lessee. The **Kosminsky mine** is probably located on the same vein system, and during the 1970s it produced specimens very similar to those from Platt.

The **Comet** and **Maestries mines** were worked from opposite ends of the same vein deposit, and in 1895 they were united to form a prolific mine which sent sixty tons of argentiferous galena

Figures 8 and 9. **Stock certificates for the Heazlewood mine (1888), type locality for crocoite, and the Adelaide Proprietary Mining Company (1890).**

Figure 10. **The cover of Wilberton Tilley's 1891 guidebook, *The Wild West of Tasmania: Being a Description of the Silver Fields of Zeehan and Dundas*.**

ore per day to the smelters (Lancaster, 1977). Fine "straw" cerussite and anglesite specimens were recovered, but apparently little or no crocoite; ore mining ceased in 1907 (Howard, 2009), and Michael Phelan's efforts to find specimens in the mines during the 1970s were largely fruitless (Bottrill *et al*., 2006). No later specimen-mining appears to have taken place, and Lancaster (1977) reported of Comet-Maestries that "today the shaft is flooded and a creek flows through the main adit." Similarly, the **Andersons, Bonanza, Kosminsky** and **South Comet mines** are quiet today: all produced crocoite ore and specimens in the 1890s, and all have been intermittently tried as specimen mines, but any specimens with firm documentation pegging them to these mines should be regarded as rare "locality" pieces.

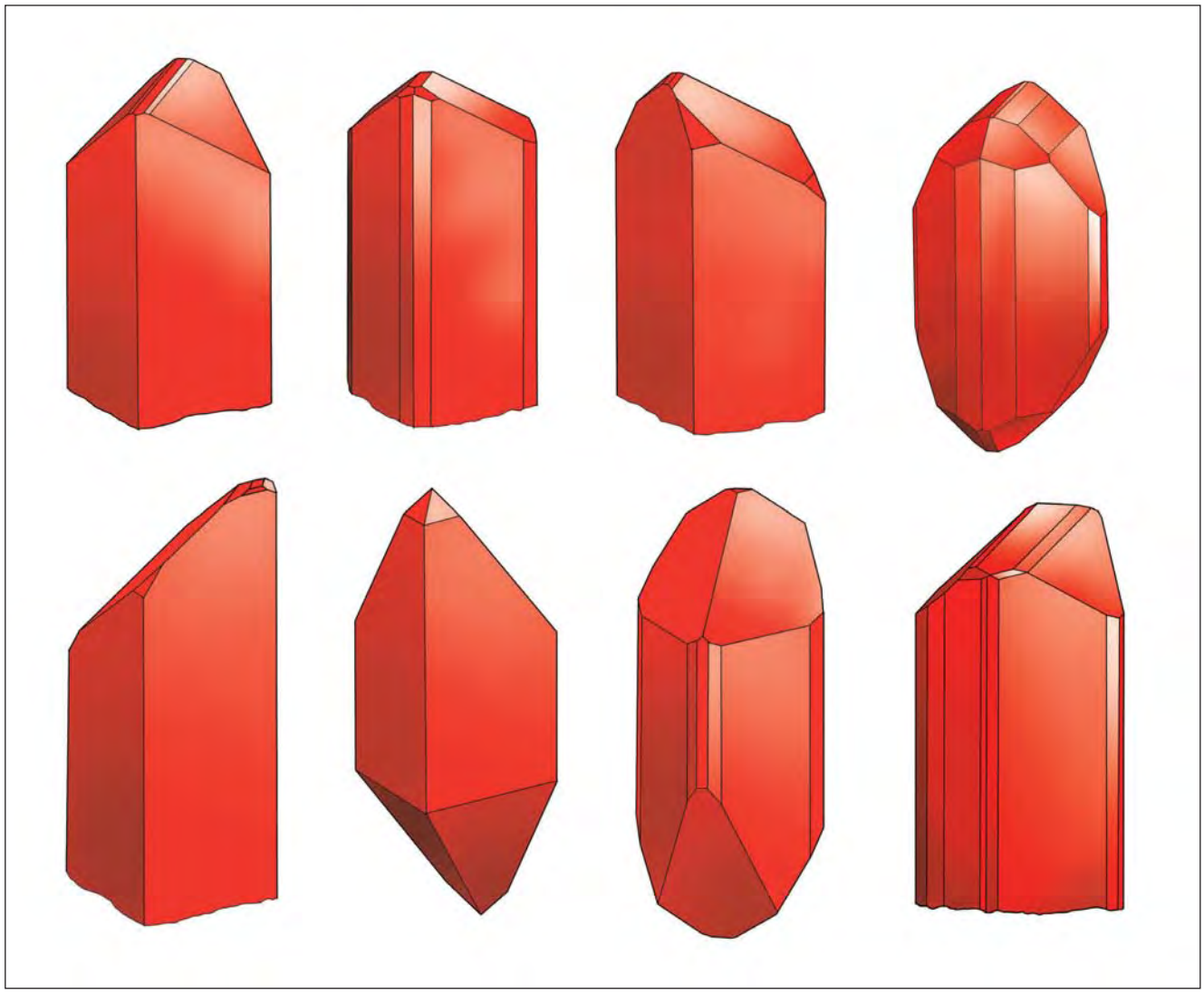


Figure 11. **Colorized crystal drawings of crocoite from Dundas, Tasmania. After Palache (1896) (top right), Van Name (1902) and Slavik (1904) (bottom right). The crystal Palache described in January 1896 came from the Adelaide mine "some time since," presumably around 1894 or 1895, courtesy of Stephen A. Douglas, a 15-year-old San Francisco collector who had obtained a number of specimens. The six crystals that Van Name described in February 1902 were purchased by Yale University from the A. E. Foote Company, from stock obtained from the Adelaide mine as well; the habits are more typical than that of the Palache crystal. Slavik (1904) said his crystal was from the same locality as the Palache and Van Name crystals. Van Name wrote: "These Tasmanian crystals of crocoite, with their superb color, high luster, and remarkably perfect crystallization, are most beautiful natural objects, scarcely surpassed by crystals of any other known mineral."**

The gossan outcrop of the **Red Lead mine**, on the southeastern spur of Stichtite Hill, was discovered in 1890, and the mine was worked for ore during the decade that followed: a notice in an 1894 edition of the *Zeehan and Dundas Herald* described a spectacular expanse of crocoite in the roof of the main adit (Bottrill *et al*., 2006). The mine closed briefly, then was revived in 1902, around which time crocoite crystals to 10 cm were noted. But the mine was closed again in the mid-1920s and lay idle until the mid-1970s, when a succession of specimen miners including Frank Mihajlowits ("Mr. Crocoite"—see below) and Michael Phelan turned their attentions to the old workings and were rewarded with several small finds. Shane Dohnt purchased the Red Lead mine in 1986 (Bottrill *et al*., 2006), and major discoveries followed. A "large lot of very fine specimens" of Red Lead crocoite was marketed at the 1988 Denver and 1989 Tucson shows (Robinson and King, 1989), and a strike late in 1991 yielded thousands of specimens, the best of them showing bright red crocoite crystals to several centimeters on matrix pieces to 30 cm across (Sielecki, 1992). In contrast to the typically hollow crocoite crystals of the Adelaide mine, most Red Lead crocoite crystals are solid, and translucent to transparent crystals are more common in the Red Lead than in the Adelaide mine. The crystal masses and jackstraw clusters are found on mottled brown/black matrix of ferromanganese oxides, occasionally with microcrystals of cerussite, anglesite, petterdite and reynoldsite and with poorly crystallized dundasite, grimaldiite and philipsbornite. Shane Dohnt is continuing to seek crocoite specimens in the Red Lead mine.

ADELAIDE MINE

Of the mines in the Dundas field, the Adelaide mine is the most prolific source of superb crocoite specimens, historically as well as

Figure 12. **Crocoite crystal cluster, 24.5 cm, from the Red Lead mine. Olivier collection; Jeff Scovil photo (1998).**

Figure 13. **Crocoite crystal cluster, 13 cm, from the Red Lead mine. Olivier collection; Jeff Scovil photo (1998).**

currently. The mine is situated at the junction of Comet Creek and Adelaide Creek, near the base of a spur of Stichtite Hill about 2 km southeast of the original Dundas townsite. It was first claimed by T. Anderson in 1890, and sold the following year to the Adelaide Proprietary Silver Mining Company. Mining began on three lodes (known collectively as the Adelaide mine), and by 1893 a number of adits had been driven into the hillside and a 176-foot shaft had been sunk. There were seven levels driven off the shaft in all different directions. The second level down was the only one which actually went back below the current workings. On this level they hit a cavity filled with clay and crocoite—and a flow of water so severe that they had to seal up the level.

Little ore of economic value was found during this early period, however, and the mine was shut down in 1895. While the mine sat idle in 1895–1901, a professional mineral collector moved in and dug for crocoite specimens (see below). In 1908 new owners took

Figure 14. **Crocoite thumbnail-size crystal cluster, 2.6 cm, from the Dundas Extended mine. Martin Rosser collection; Jeff Scovil photo (1995).**

over and opened the 220-foot level, where commercial grades of lead-silver ore were finally found. By the time the mine closed again in 1915, 1,479 tons of lead and 147,000 ounces of silver had been recovered, as well as nearly 3,000 tons of gossan rich in silver and lead that was used as flux for the Zeehan smelters.

Crocoite was common in the gossan, but open pockets yielded the best specimens. Brilliant, hollow, long-prismatic crocoite crystals to 15 cm emerged in the days of ore mining, and during the years 1898 to 1901 the Adelaide became briefly a "specimen mine" when field collectors found a crocoite bonanza. Philadelphia mineral dealer Warren Foote, manager of the Dr. A. E. Foote company, first began advertising the crocoite specimens in the May 1898 issue of *The Mineral Collector*, saying: "No low priced specimens. But good ones are cheap at $5 to $8 each. A great investment for collectors who are on the lookout for something startling. They are sensational. Ask those who have seen them." Foote reported as follows in a company catalog of 1898:

> The discovery of new forms of this wonderful mineral is the result of over a year's work of our collector, in which the old Siberian specimens were totally outclassed. The various Tasmanian mines yielding the chromate of lead have been abandoned for some years and offered no hope of specimens in the future, the water in the levels having ruined all the specimens in the porous rock. The surface indications at the Adelaide appeared to warrant operations, and a tunnel was driven into the Hill above. After much expensive labor a number of fine, rich colored crystals on dark gangue were found, and a good supply of pure massive Crocoite saved. Further on, however, in a clayey deposit, our collector was fortunate to strike a patch of loose prisms 3–9 cm long, superbly terminated, and of a most gorgeous translucent to transparent scarlet-red. The planes are exceptionally brilliant, and the angles of ideal sharpness and perfection. . . . Only a few perfect crystals were saved as compared with the number of broken, but otherwise choice crystals. Following this great strike, several months of fruitless and expensive tunneling forced an abandonment of the work, at a depth of 232 feet, closing the most extensive mining ever done solely for scientific mineral specimens.

Shortly after Foote began offering specimens from the find, New York mineral dealer Roy Hopping also obtained specimens and offered them in the August 1898 issue of *The Mineral Collector*, writing:

> Crocoite from Tasmania: Among the many new arrivals from various localities recently received the most important is a small shipment of a dozen fine cabinet specimens of the beautiful, rare crimson chromate of lead CROCOITE from the silver-lead mines of Tasmania.

In September 1898 Hopping received another shipment, advertising over 20 small crystal groups at 50c, 75c, $1.00 and $2.00. And yet another shipment arrived in December 1898.

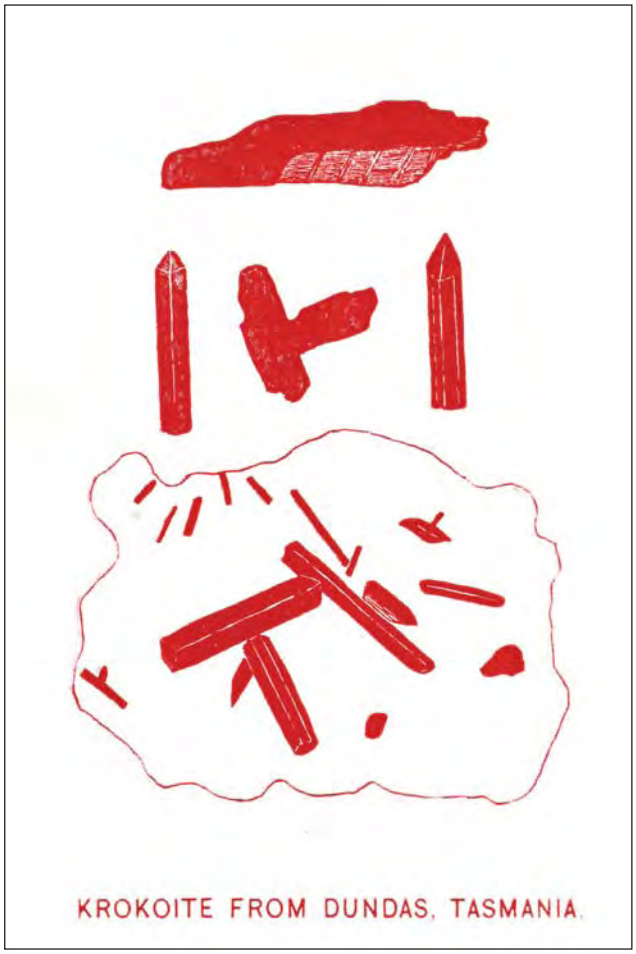


Figure 15. **Crocoite crystals illustrated in the November 1898 catalog of New York mineral dealer Roy Hopping. These are doubtlessly from the same find as that marketed by the A. E. Foote company in 1898. "During the summer," wrote Hopping, "we received two small shipments of this exceeding rare and beautiful mineral from the Dundas locality and can offer small groups very cheap, mounted, at 50c, 75c, $1.00. A few large groups, fine crystals, $2.00 to $500 [probably a misprint for $5.00]."**

Figure 16. **The Adelaide mine. Adam Wright photo.**

Figure 17. **The Adelaide mine, lower adit and flooded 1890s shaft. Adam Wright photo.**

Figure 18. **The Adelaide mine, current entrance. Adam Wright photo.**

In May 1899 Warren Foote received a "new consignment" of crocoite specimens: "Although an old find, they were but recently brought in by our collector." It was said that only poor specimens could be collected on site. However, Foote's Australian collector persevered, and in October 1900 Foote announced additional, spectacular finds:

The entirely new types of crocoite received were the result of seven months work of our collector, who had previously made several trips to Dundas. The various mines yielding the chromate of lead in the past eight years [i.e. since 1892] are now abandoned, offering but little hope for specimens in the future. The surface indications at one of these flooded

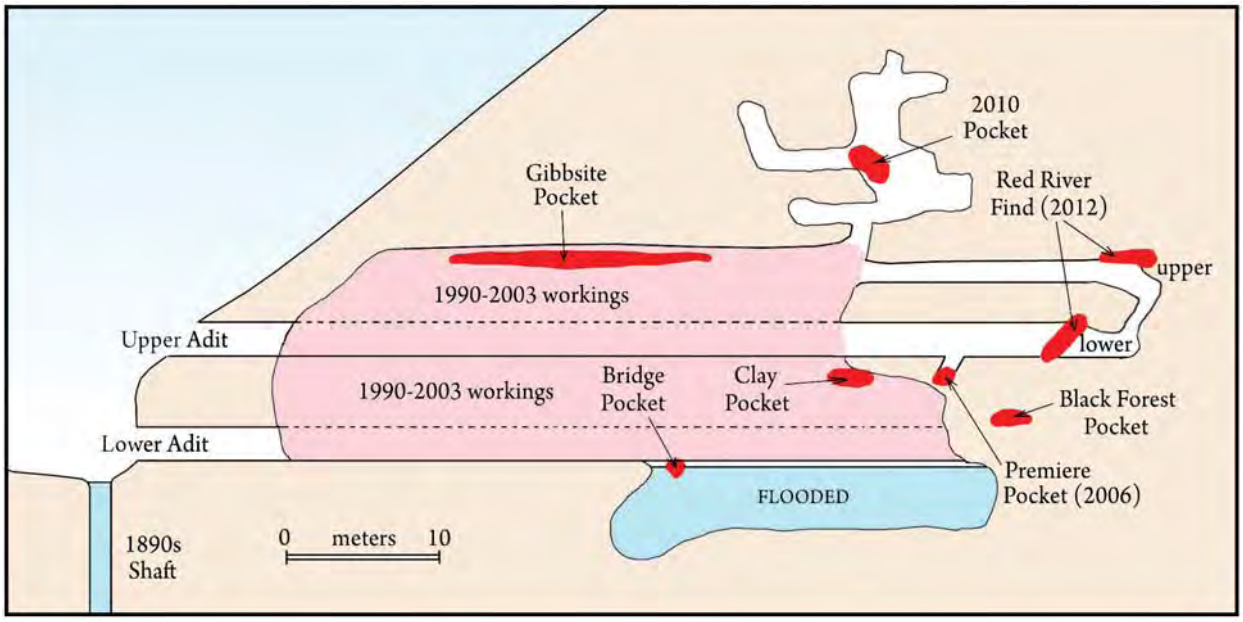


Figure 19. **Longitudinal section of the upper workings of the Adelaide mine (above the water table) showing the location of the area mined by Frank Mihajlowitz in 1990 to 2003 (pink) and the pockets found by Adam Wright since taking over the mine in 2003. Earlier workings extend from the main shaft sunk in the 1890s and now flooded. Information courtesy of Adam Wright.**

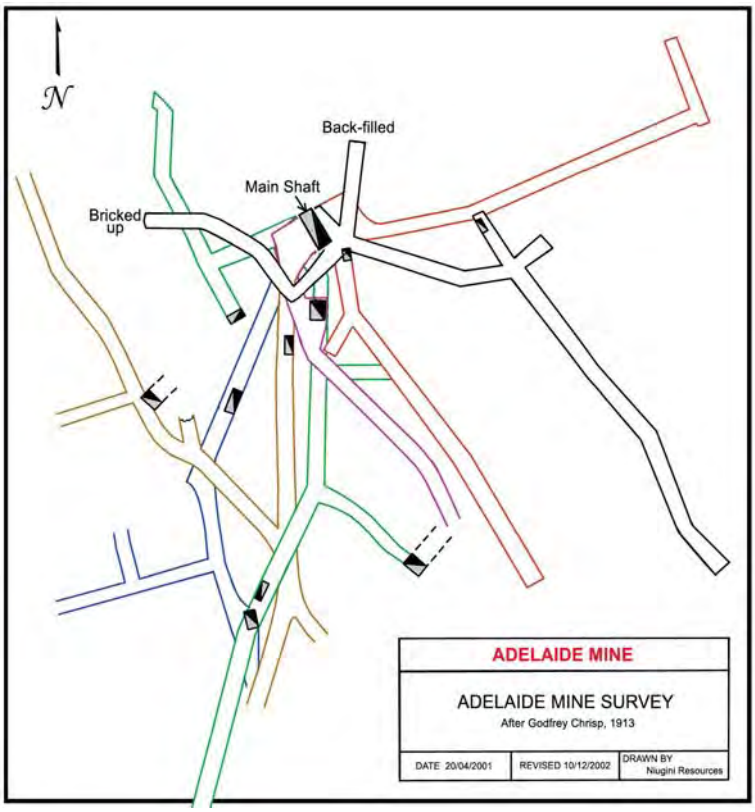


Figure 20. **Plan view of the various levels of the Adelaide mine below the water table (now flooded). These workings, all extending from the main shaft sunk in the 1890s, were the source of specimens found in 1893–1910. Based on a mine survey by Godfrey Chrisp in 1913, revised by Nuigini Resources in 2002.**

mines appeared to warrant operations, and a 100-foot tunnel was driven into the hill above. After much expensive work a comparatively large quantity of fine, rich colored crystals on dark gangue were found, and a good supply of pure massive crocoite saved. Aside from this bulk of material, however, our collector was fortunate enough to strike a patch of loose crystals, two to four inches long, superbly terminated, and of a most gorgeous translucent to transparent red. The planes are exceptionally brilliant, and the angles of ideal sharpness and perfection. The crystals range from an eighth to a half inch in thickness, with various types of terminations, from a single face to four or five. The consensus of the enthusiastic expressions heard in Paris, was that not only were the new crocoites incomparably superior to former finds, but that they belong in the first rank of natural crystallizations. In fact, it was remarked of these unexpected marvels of form and color, that they seemed almost artificial!

In April 1901 Foote announced yet another batch of crocoite specimens:

TASMANIA: Four cases packed in the chromate-yielding lead mines were delivered in Philadelphia about the middle of March. Advices from our Australian agent state that he, with the assistance of two laborers, worked one of the abandoned tunnels, and by stoping and extensive timbering, opened a fresh deposit of crocoite. Types do not differ from those

Figure 21. **Crocoite crystal group, 3 cm, from the Adelaide mine. Bill Larson collection; Harold and Erica Van Pelt photo.**

> received in previous shipments, but the quality and perfection of crystallization place them far in advance of any hitherto offered from this store. Picture, mentally, single crystals *three to five inches in length*, with perfect termination, rich color and translucent quality.

By 1905 Foote had shifted the focus of his business to supplying industrial-grade minerals by the ton, and never offered crocoite again.

In the mid-20th century a specimen-seeking miner named Smith put in several years of hard work in the Adelaide, coming up with "a considerable amount of crocoite, mostly of mediocre quality, but also some very fine specimens" (Chapman, 1972). One person who worked with Smith was Frank Mihajlowits, an immigrant from Austria who would come later to be called "Mr. Crocoite of Zeehan" or "The Crocoite King." In 1970, Mihajlowits leased the Adelaide mine, soon commencing exploration of its old workings and in due course adding new ones. In 1971 (Bancroft, 1984; Haupt, 1988; Bottrill *et al*., 2006) Mihajlowits opened a crocoite "cave" measuring about 1.5 × 2 × 2.7 meters with walls solidly covered by crocoite crystals. From the cave he took around 1,000 specimens in a full range of sizes, with individual crocoite crystals to 8 cm long. Chapman (1972) described the find as follows:

> One day in July, while working alone, Frank broke into a large cavity some eight feet long, six feet high, and four feet six inches wide. Enlarging the hole big enough to hold his light an arm's length into the cavity, Frank was spellbound by a scene of sparkling beauty, such as few men have ever witnessed. The roof, walls and even the floor were completely covered with crocoite crystals of all sizes, from the dimensions of pins to a few that exceeded 3 inches in length. All were terminated and of the finest color. Not since the heyday of the mine had anything like it been seen!

The next major discovery of crocoite in the Adelaide mine—the largest so far known—was signaled in late 1990, when Mihajlowits hit the upper part of what turned out to be a 14-meter-long watercourse. Little material could be recovered from this first breakthrough point without dropping detritus onto the better material visible beneath, so Mihajlowits' crew went back out to the surface and cleared a work face lower on the hill slope, intending to gain access from below. By early 1992 they had intersected the watercourse again but found that they still had not reached its lowest level; accordingly they ramped down even further, to the level of the water table. When the flow of groundwater became an issue they began working upward, clearing out large areas between the levels. The first large batches of crocoite specimens began to emerge in late 1992/early 1993: magnificent pieces with deep red-orange crocoite crystals reaching 10 cm long in very large clusters, with white and yellow cerussite, dundasite, phosgenite, pyrite and other associations (Kissling, 1996; Adam Wright, personal communication). During the

Figure 22. **Crocoite crystal group, 15.2 cm, from the Adelaide mine. Note the hollow crystals. Steve Smale collection, acquired 1998; Jeff Scovil photo.**

14 years it took to exploit the **1990 watercourse** fully, thousands of fine crocoite specimens were recovered, although, inevitably, the extreme fragility of the crystals and the weak, waterlogged state of the gangue meant that many thousands more specimens were severely damaged, and at least that number again were destroyed (Praszkier and Wright, 2011).

Adam Wright (personal communication) has provided information on some of the smaller pockets that were given names (for locations see the mine diagram, Fig. 19). The **Gibbsite Pocket** is the name they gave to the top section of the 1990 watercourse. Mihajlowits mined some material from this area but left more up in the roof which Adam Wright took out when he first started at the mine. All of the crocoite above a certain point in the 1990 watercourse was thickly coated with gibbsite. The conditions under which gibbsite formed in this area appear to have been acidic, as the crocoite remaining underneath is very etched and scarred when the coating is removed. There are up to seven different layers or generations of growth visible in some of these gibbsite specimens, and some of the first-generation crocoite crystals are over 20 cm long.

Mihajlowits had rail tracks laid on the lower level of the 1990 watercourse along which a small (manual) rail truck ran. This was used to carry his waste rock outside to the dump. In time they mined out sections underneath this track but they left some patches as bridges to support the tracks. During Adam Wright's operation he installed new timbers around these pillars so that he could then mine them out. One of these pillars, which he named the **Bridge Pocket**, yielded a modest number of nice specimens.

The **Clay Pocket** was a clay-filled area left by Mihajlowits. The clay ranged from very soft to concrete-hard and was riddled throughout with crocoite. This crocoite was greatly fragmented and was mainly small pieces although there was the odd larger chunk present as well.

At the end of the 1990 watercourse on the lower level Mihajlowits opened up an area where the walls were covered with black radiating sprays of crocoite up to about 8 cm long. They thought it looked like a Black Forest, hence the name **Black Forest Pocket**. Adam Wright mined out some of this material and found that the crocoite had actually been replaced by some kind of iron oxide. When the specimens dry out they become incredibly light, soft and fragile, to the point that most of them disintegrate—which is why Mihajlowits had left the pocket behind.

In 2004, after more than 30 years of collecting crocoite, Frank Mihajlowits sold the Adelaide mine to Adam Wright's newly established Adelaide Mining Company Pty. Ltd., which continues to mine for specimens to this day. The company's first big discovery came in April 2006, when the miners broke into a vertical cavity, up to

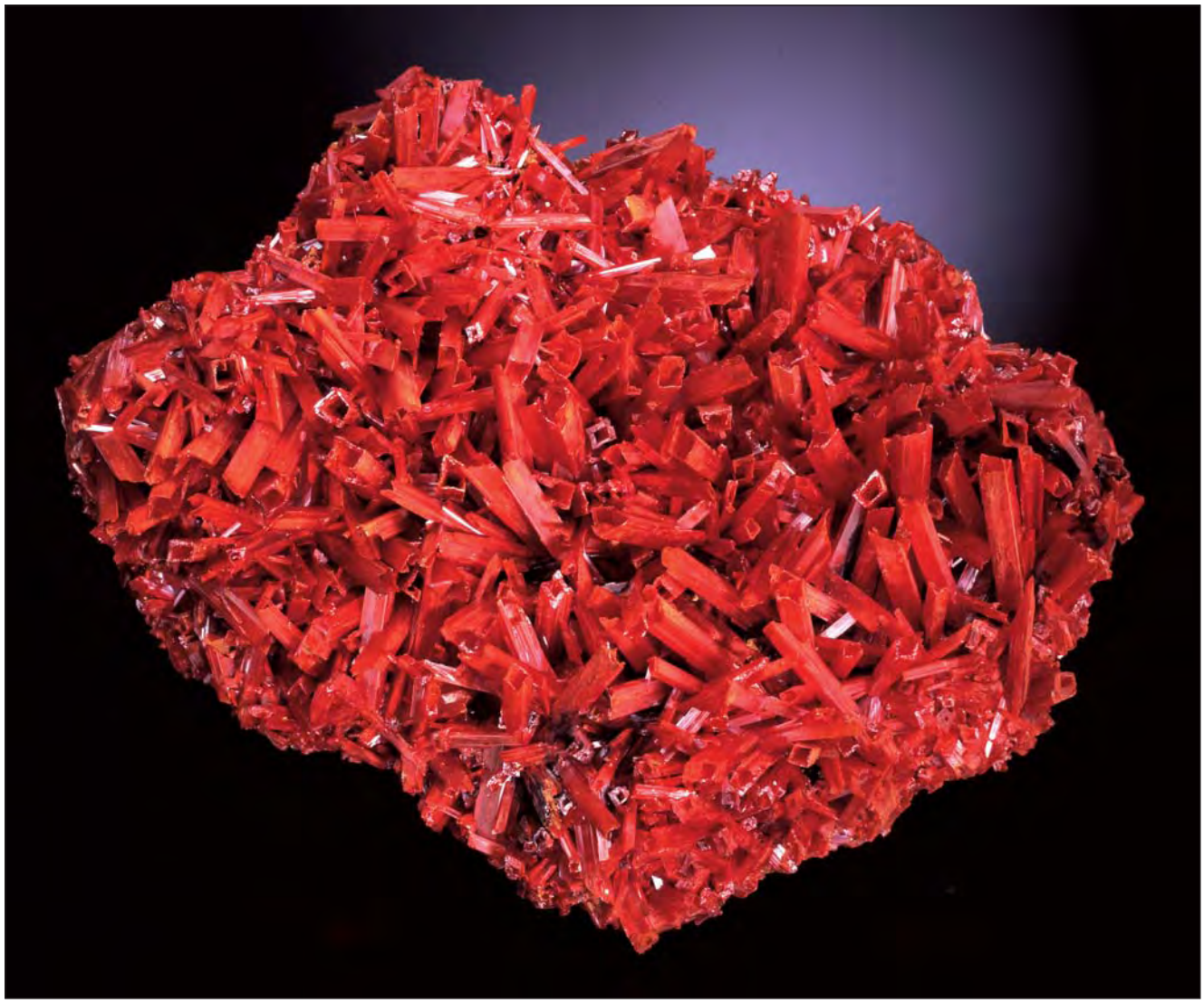


Figure 23. **Crocoite crystal group, 19.8 cm, from the Adelaide mine. Note the hollow crystals. Lyda Hill collection; Jeff Scovil photo (2007).**

50 cm wide, densely crisscrossed by crocoite crystals. Careful collecting of the "Premiere Pocket," as it was named, produced about 200 excellent crocoite specimens, ranging from loose, terminated, thumbnail-size prisms to large cabinet-size pieces showing crocoite crystal jumbles on earthy brown, gibbsite-coated matrix.

In 2010 yet another major pocket was found during work to intersect the watercourse which had fed into the top of the 2006 pocket. A succession of raises gradually revealed a vuggy area which grew wider and richer in crocoite as work progressed, ending in a crystal-lined chamber measuring 45 cm × 1 meter × 2 meters. About 350 fine crocoite specimens came from this find, not including the many loose crystals which had fallen from the hanging wall to the floor of the chamber; the largest crystal that is part of a cluster is 14 cm long, and terminated. Praszkier and Wright (2010, 2011) give accounts of the 2010 find; see also Greene (2012), who shows pictures of the pocket as it looked at different stages of mining. Some specimens from the 2010 pocket were marketed at the 2010 Munich Show (Wilson, 2011), but the majority were taken to the 2011 Tucson Show, where they were very well received (Adam Wright, personal communication, 2012).

It is commonly stated by collectors that nearly all of the crocoite found in the Dundas mines in the early years was regarded simply as flux material and trucked away to the Zeehan smelters. However, early mine records indicate that the smelters actually sought the ferro-manganese gossan rather than crocoite itself, and it is reasonable to think that the miners saved the very best crocoite specimens, as these were acknowledged even then to be valuable. One mine inspector recorded his surprise that crocoite specimens were being regularly sent to museums and private collectors overseas. And it is thought today that the many high-quality European mineral specimens in various Tasmanian museums were obtained around 1890–1910 by the exchange of crocoite for specimens from European collections, although unfortunately there are few records to confirm this (Ralph Bottrill, personal communication).

But it remains true—sadly—that great quantities of crocoite found in the Dundas mines during the period of ore mining (*ca.* 1885–1925) were destroyed in the Zeehan smelters. Observing that most crocoite from the Red Lead mine was meeting this fate as late as the 1920s, Bancroft (1984) evokes horse-drawn trucks headed to the smelter with "thousands of kilograms of crocoite 'blinding in the sun.' Some chunks of crocoite crystals, too large to lift by hand, were broken down before loading." The specimen-collecting efforts of Warren Foote's agent in 1898–1901, and the mercies of many anonymous early miners, are all to the good, but still it is

Figures 24 and 25 (left and above). **The Premiere Pocket of 2006. Note the heavy dark oxide material which will later be chemically removed from the specimens. Adam Wright photo.**

almost solely the hard work of specimen-miners from 1970 to the present which has made contemporary collectors aware of this major mineral occurrence, and has provided collections worldwide with beautiful "Dundas" crocoite specimens.

THE 2012 "RED RIVER FIND"

News of a major new pocket of crocoite found in 2012 brought great excitement. We decided that it needed to be documented, so I (Tom) was chosen to go to Tasmania and reconnoiter, as Adam Wright's guest. Bryan Swoboda and I rendezvoused in Los Angeles, weathered the 17-hour flight to Sydney, did a bit of sightseeing in that attractive city, and then flew to Hobart—Tasmania's capital and, with about 220,000 people, home to half of its population. But there was no time for further sightseeing. We heaved Bryan's five large bags full of camera and video equipment into our rented all-wheel-drive van and set out—driving on the left side of the road, like good chaps—on the four-and-a-half-hour trip to meet Adam Wright at The Adelaide Mining Company's office in Zeehan.

As this meant crossing the island's entire expanse from its south-eastern to its northwestern coast, there was much scenery to take in. Once out of the Hobart suburbs and past some placid stretches of farmsteads and grazing livestock, the road began climbing towards the central highlands, and signs of human activity grew more sparse. We did pass extensive tracts where the highland rainforest had been logged off and replanted, perhaps several times, and we saw hydro-electric facilities, and enormous pipes to bring water down from the heights, and one or two tourist hotels and even a golf resort. But increasingly the uplands grew cooler and emptier, and soon we were passing Alpine-like stands of pencil pine, King Billy pine, Giant Grass Trees and still other flora I had to look up in the guidebook. And there were stretches of bare, swampy heath unfurling between the evergreen islands. Patches of snow appeared by the roadside, and the clearing sky staged stratocumulus extravaganzas, while in the distance rose isolated, round-topped, snow-capped peaks.

Coming down on the island's west-facing slope, we entered the Franklin-Gordon Wild Rivers National Park, where things get *really*

Figure 26. **A horizontal pocket discovered shortly before the main 2010 Pocket. Adam Wright photo.**

Figure 27. **Part of the 2010 Pocket (note pry-bar for scale). All of the dark coating on the crystals will later be removed by chemical treatment. Adam Wright photo.**

Figure 28. **A clean vuggy area in the 2010 Pocket. Adam Wright photo.**

exotic. Now the narrow blacktop road traversed forests of eucalyptus and "man ferns" (so-called for being "the size of a man," though many I saw, I swear, were 20 feet tall and almost as much across), and the light grew dim, and green shadows themselves seemed to exude moisture. I thought of *Jurassic Park*—but no sooner had I begun imagining that a Triceratops might lumber out of the gloom and stand on the road ahead of us than, instead, a wallaby, furry brown and about three feet long, did just that. Bryan pumped the brakes but the wallaby remained in place, staring up at us stupidly until we couldn't avoid hitting it. We were told later not to feel too guilty: wallabies don't have much traffic sense but they are very common in Tasmania, and indeed we saw three of them loping around in the dusk in Adam and Erika's back yard after we finally reached their home.

On the next day, having inspected Adam's crocoite stocks and having filmed an interview with Tasmanian-minerals expert Ralph Bottrill for Bryan's DVD, we headed at last for the Adelaide mine. The dirt road to the mine from Zeehan is short, mostly level, and only a little rutted and bumpy; at the mine site it expires in a clearing in front of a shed where supplies, wetsuits and hot coffee are available. Only one gawker at a time can get into the narrow drift from which the Red River Find is visible, so while waiting my turn I hiked up a trail of switchbacks leading to the top of Stichtite Hill. On the first switchback up from the mine entrance there is a "bottomless" pit, now roofed with a few logs, which marks the site of the great pocket that Frank Mihajlowitz found in the early 1970s. He cleaned the pocket out from below (as the Adelaide Mining Company is doing for the present one), and so this hole is the place where Mihajlowits broke through to sunlight. Along the trail farther up there are numerous vertical cuts and shallow adits going into the hillside. Spectacular views out over the forested mountains—as far as the one called Mount Razorback—open like fans on the switchback-turnings.

But then it was back downhill to the mine. From the clearing, three mine entrances can be seen, only one of which, hard by the changing-shed, is the "working" entrance. The other two, on a level slightly below it, flank a water-filled pit and are older and disused. One of these is the mine's original entrance, developed in the late 1880s; the other, framed by a wooden portal, is the adit that Mihajlowitz dug in 1990–1992 in order to get at the great 14-meter-long

Figure 29. **Another vuggy portion of the 2010 Pocket zone. A first generation of crocoite has a dark brown oxide coating (later to be removed), and a second generation of smaller crystals remains uncoated. Adam Wright photo.**

watercourse (as recounted above). To walk from the clearing to the edge of the water-filled pit near the latter entrance is to tread on a reddish-brown apron of waste that the miners call "the red carpet," since it consists of earthy brown grains of limonite/goethite, much mud, and millions upon millions of crocoite crystal fragments. With every step I could hear the breakings of myriad little red bones: a patient visitor with a sieve and a water supply could find as many small-thumbnail-size crocoite crystals as could be conveniently carried off, and a few may even be undamaged and/or terminated.

The mine entrance now in use, behind the shed, was also begun by Mihajlowits in the early 1990s. About 50 meters in, one climbs up a few rungs on a steel ladder, turns right at the top of the ladder, squirms into a narrow, muddy drift and proceeds about 10 meters down that crawlway—and there it is: the mouth of the Red River Find.

From this vantage, the opening of the watercourse is about a meter wide and 2 meters tall. A headlamp aimed into it must be positioned carefully if it is to show the whole exposed length of the curving channel, no end to which can be seen. Thick veins of waterlogged oxides form bulges and random recessions along the walls, and all surfaces are completely covered with fiery red to red-orange crocoite crystals bristling out towards the hollow space in the center. The crystals are of varied lengths, and the angles at which they protrude also vary, and so it is hard to guess at an average dimension, but many crystals are clearly 5 cm long and more. In some areas the crystals form bunches and knots anchored weakly in the oxide gangue; in others there are little families of crystals crossing at acute angles, like firearms stacked in surrender. Everything, everywhere, glistens, or even seems to secrete water droplets, as if the door to the workshop has been opened a little too soon. Farther back in the channel there are only blurred reds and blacks, and pristine silence; in its farthest reaches, where no individual crystals are visible, orange points of light stand bodiless in the dark like abiding secrets. I stared, aiming my light here and there, for some "who cares?" period of time. The sight is formidably beautiful, and the knowledge that we have *surprised* it, and soon will remove it, weirdly unfixes the mind, bringing on an odd compound of wonder, mystery and disquiet. I was shocked to notice my own strong urge to thrust an arm into the hollow space as far as I could . . . what I'd grab onto if I did so was unclear, and I knew of course that, if I reached in, my arm would brush against many crocoite crystals and snap some in two like toothpicks. But I wanted in the worst way to *touch* what I saw, like an eager tourist or reverent acolyte, or like a vandal . . .

Behind me, Adam started at some point to explore with his fingers a small vuggy zone he had noticed on the adit floor, near my right

Figure 30 (left). **One of the specimens removed from the 2010 pocket, before cleaning. Adam Wright photo.**

Figure 31 (below). **The same specimen as shown in Figure 30, after cleaning. Adam Wright photo.**

foot. When, backing out at last, I saw that he'd left his prybar and hammer behind, so I called down to him to ask if I might try to extract some specimens from the zone, and he kindly said yes. For the next half-hour I worked at taking out matrix crocoite specimens: driving the prybar, with gentle taps, into the muddy oxide mixture until a more or less solid matrix plate could be loosened, then grasping each plate with my fingers, twisting and teasing them out. A dozen specimens emerged from this little "Mineralogical Record Pocket," as I decided to call it, and even though they are run-of-the-mill specimens I kept checking in on them possessively as they dried in the sun. The four specimens which I took home with me—in a carry-on, keep-this-side-up cardboard box which inspired many questions from the security people at three airports—made it safely to Tucson, where I presented one specimen each to my three trusty colleagues at the *Mineralogical Record*.

However, "my" specimens turned out to be mere chaff compared to about ten others which Adam took from the mine, with every appearance of casualness, while I was there. These too had to dry in the sun, and in several of them, as they dried, about half of the crocoite crystals were seen to be coated by thin, opaque, brown films, largely of finely divided goethite and gibbsite. The coatings themselves (not the crystals beneath them) discolored more strongly within an hour, almost as we watched. Of course these coatings can be removed by chemical treatment, but as the crocoite crystals are so unspeakably delicate it seems impossible that such treatment can be applied without causing damage. But Adam Wright swears by the technique, which involves a phosphoric acid bath and some proprietary procedures: for illustrative "before" and "after" pictures of a crocoite specimen from the 2010 pocket, see Wilson (2011).

The best specimen brought out by Adam that day is a 12-cm, alarmingly crumbly, brownish black matrix from which a fantastic maze of crocoite crystals rises a full 5 cm, the whole of it fully as wide as the matrix supporting it. To each red-orange crocoite stalk in that maze a few tiny sprays of later crocoite crystals adhere

Figure 32. **Adam Wright with a flat of specimens just removed from the 2012 pocket. Bryan Swoboda photo.**

Figure 33. **Adam Wright with some of the specimens from the 2010 Pocket.**

excruciatingly delicately, like dandelion seeds which have happened to perch there in passing. This is the most delicate mineral specimen I have ever seen; I was afraid to go near it. But when it, too, began to discolor, and I asked Adam what he could do about that, he said, oh, he would clean it right up, and then he would take it to Munich, and if it didn't sell there he would take it to Tucson. Let us all stand amazed (as I did that day) at the enterprise and sheer courage of mineral miners, like Adam, who do such difficult, wonderful things for us collectors.

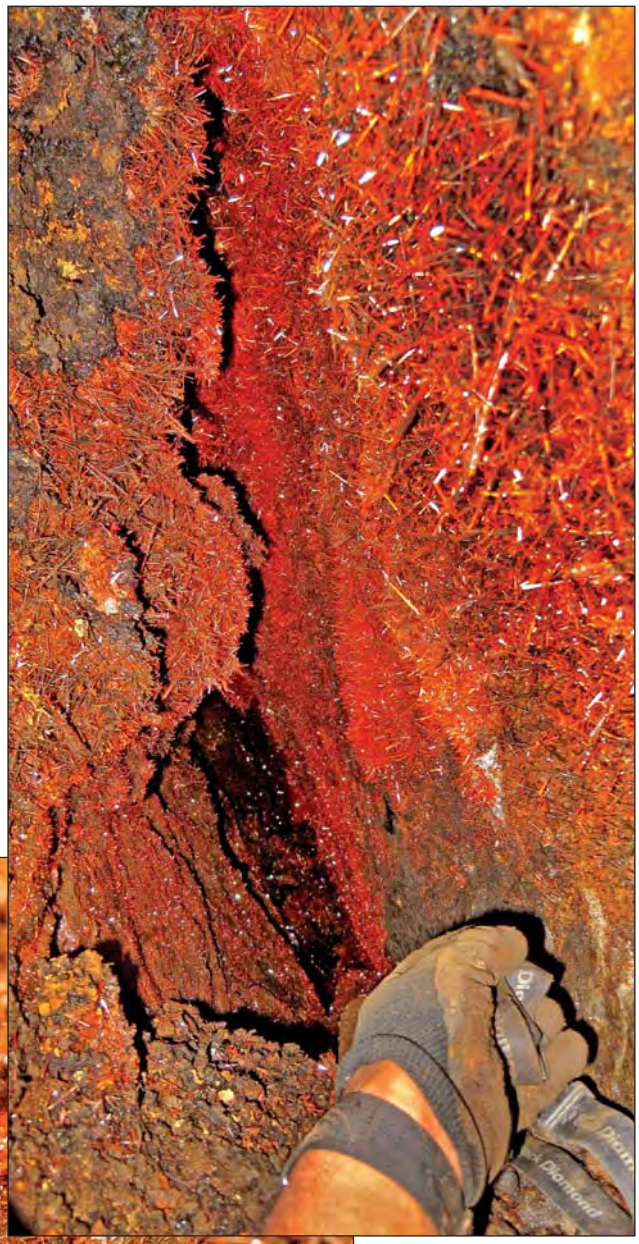
CONCLUSION

As I am finishing this account it is early September 2012, and Adam Wright has sent an e-mail with news of a just-completed "three days of very productive mining" of the Red River Find. The watercourse has been broken into from below, and a new and wider view of the hanging wall has been created, where hundreds of new crocoite specimens are being harvested. This good news has the somewhat eerie (for me) corollary that the narrow, dark watercourse as described above no longer exists: the view of the

whole vuggy region is now much wider, roomier and better lit than before. Although no end to the channel has yet been found, the prospect is now a busy *workplace*, no longer a spooky entranceway into the haunts of Hades, god of darkness and underground wealth. But, of course, no such quasi-mystical consideration will keep me from shopping for one of the beautiful crocoite specimens from the Red River Find when selections appear, as they surely will, on the show scene soon. And so I will see you there, fellow shoppers.

ACKNOWLEDGMENTS

For supporting my visit to Tasmania to view the Red River Find, I thank Adam Wright, and for their faultless hospitality at their homes in Zeehan and Margate I thank Adam Wright and Erika Aheimer. For being an excellent traveling companion and partner in adventure, my thanks to Bryan Swoboda—and thanks from all *Mineralogical Record* readers are owed to Bryan for his production of the accompanying DVD. For letting us in on so much of their major knowledge of crocoite, and of Tasmanian minerals in general, we thank Ralph S. Bottrill and Adam Wright. Sincere thanks as well to Adam Wright, Jeff Scovil and Bryan Swoboda for the use of their excellent photography. And very hearty thanks to Dehne and Maureen McLaughlin for letting me hitch that long ride with them from Zeehan to Hobart—where I had the treat of examining their fine mineral collection.



Figures 34 and 35. **Two views looking back into the 2012 Red River water-course. The full extent of the pocket is unknown. Bryan Swoboda photo.**

Figure 36. **Author TPM, freshly emerged from the crocoite-laden depths of the Adelaide mine, with a wooden flat of specimens. Bryan Swoboda photo.**

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