QUEENSLAND BOULDER OPAL

By Richard W. Wise

After almost 75 years of inactivity, the deposits of boulder opal in Queensland, Australia, began to attract new interest in the 1960s and 1970s. Queensland boulder opal is found associated with the Winton formation, and results from deposition and dehydration of silica-rich solutions in an iron-rich host rock. At the Cragg mine, one of 69 known opal-mining operations in Queensland in 1991, miners drill as deep as 20 m to search for a deposit and then use open-cut methods to reach the opal-bearing layer identified. In the evaluation of boulder opal, color, pattern, and "composition" are important. Most boulder opal is stable under normal wear, and it is readily separated from its simulants.

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B*oulder opal* is the term used to describe gem-quality opal that occurs in veins and pockets in ironstone concretions, and retains some portion of the ironstone when cut. Most boulder opal on the market today is found in association with the Winton formation, a broad belt of Cretaceous sedimentary rock that covers the entire center of the state of Queensland, Australia. After several years of intense mining in the late 19th century, interest in Queensland boulder opal waned as the harsh climate drove miners to more lucrative deposits in areas such as Lightning Ridge and Coober Pedy.

In the early 1970s, however, significant quantities of Queensland boulder opal again entered the gem market, and interest surged as dealers and consumers alike were drawn to the unusual shapes, intense color, and artistic qualities of the Queensland material (figure 1). With the increase in opal mining throughout Australia over the last several years, there has been a parallel increase in mining in Queensland. Government figures show that at the height of recent production, 1987–88, Queensland accounted for more than 6% (in value) of all opal produced in Australia, or Aus$6,602,000 (US$5,241,988; table 1).

This article briefly reviews the history, geology, formation, mining, and gemology of boulder opal from central Queensland. Specific reference is made to current workings at the Cragg mine, a typical open-cut opal-mining operation, which the author visited in March 1990.

HISTORY

Although Pliny, in 79 A.D., and later Tavernier in 1675, referred to ancient deposits of opal in India, the only early deposits that have been confirmed are located southwest of the northern end of the Carpathian Mountains in what is now Czechoslovakia (Loneck, 1986). This was the principal source for opal worldwide until Australian discoveries in the late 19th century revolutionized the industry.

"Precious" opal was first discovered in Australia at Listowel Downs (sedimentary) and Springside (volcanic), in

Figure 1. Over the last two decades, Queensland boulder opal has reappeared in fine jewelry in the U.S. and elsewhere. This 11.16-ct boulder opal is set with a 0.96-ct red spinel and a 2.29-ct lavender sapphire. Courtesy of Paula Crevoshay, Upton, MA; photo © Harold & Erica Van Pelt.

Queensland, in 1872 (Loneck, 1986). Commercial mining peaked in 1895, and then declined sharply when extended periods of drought made it impossible to work the fields (Jackson, 1902). Early miners valued only pipe opal and seams thick enough to cut solid opal. Boulder opal was virtually ignored. Discovery of opal elsewhere in Australia—at White Cliffs in 1890, Lightning Ridge in 1903, and particularly Coober Pedy in 1915 (Keller, 1990)—subsequently diverted the attention of miners and dealers alike.

In the 1960s, however, some independent miners began reworking old claims, now using heavy equipment that could accomplish in hours what had taken their predecessors—equipped with only hand tools—days or even weeks in the harsh climate. Mining activity increased dramatically in the early 1970s, peaking in 1974. After that, production increased only gradually, and it actually declined in the early 1980s (Krosch, 1983). Mining activity exploded again in the mid-to-late 1980s, only to slow in the current decade. All mines are privately owned. As of 1991, there were 69 individuals, partnerships, and companies officially involved in opal mining in Queensland (PGIQ, 1992).

George Cragg, who has been credited with the discovery of opal in the Winton district (V. Evert, pers. comm., 1993), discovered opal in the area of the present Cragg mine in 1888. In 1970, two 100 m^2 claims owned by George Cragg's son, Fred, were combined to form the current mine. In 1986, this claim was officially filed as part of mining lease number 17. The Cragg mine has been productive intermittently since 1970. Typically, only three people are involved in the actual recovery of opal at any one time.

LOCATION AND ACCESS

The Winton formation is a belt of Cretaceous sedimentary rock that covers an area 400,000 km^2—about the size of California—in the center of Queensland (figure 2). Key mining centers are Yowah, Toompine, Quilpie, Jundah, Opalton, Mayneside, Carbine, and Kynuna (O'Leary, 1977; QDM, 1988). Despite the introduction in the 1970s of geophysical prospecting, as well as aerial and satellite photography, most areas now being worked are part of, or adjacent to, areas mined by prospectors in the 1890s (V. Evert, pers. comm., 1993). Much of this vast, potentially rich area remains untouched (QDM, 1988).

The climate of central Queensland is semi-arid. Temperatures are subject to extreme seasonal fluctuations, with heat in excess of 50°C (122°F) recorded during summer months (October to December). The normal range in summer is 25°C at night to 40°C during the day (77°–104°F). Winter (May to August) temperatures fluctuate between 5°C at night and 20°C during the day (41°–68°F). The monsoon season usually has an greater impact on mining than temperature does. Because nearly 70% of precipitation occurs from January through March, mining normally begins in late March and ends by early November. However, a deluge at the end of March 1990, shortly after the author's visit, forced air evacuation of many miners isolated by the rains, and halted mining activities for several weeks (V. Evert, pers. comm., 1993).

TABLE 1. Rough opal production in Queensland and in all Australia for fiscal years 1981–1992.[a]

Year	Queensland	All Australia
1981–82	Aus$ 842,000	Aus$ 45,374,000
1982–83	1,395,000	42,131,000
1983–84	955,000	45,987,000
1984–85	1,346,000	45,079,000
1985–86	2,110,000	49,950,000
1986–87	2,102,000	67,425,000
1987–88	6,602,000	106,077,000
1988–89	Not available	115,000,000
1989–90	4,250,220	117,000,000
1990–91	3,221,000	Not available
1991–92	1,269,000	Not available

[a] *Sources: ABS (1981–82, 1987–88) and* Queensland Yearbook 1992 *(1992). Figures are total production figures for all types of opal, however, the vast majority of opal from Queensland is boulder opal.*

Access to major towns such as Winton, Quilpie, Longreach, and Mt. Isa is possible via regularly scheduled regional airlines from Brisbane and Townsville. Well-maintained, tarred roads connect these population centers. The trip to the Cragg mine, 175 km southwest of Winton, took approximately two hours over an improved two-lane gravel road, followed by two hours' travel by four-wheel-drive vehicle over an unimproved dirt road. Because of the harsh climate, the Queensland government strongly urges motorists to use caution when traveling in these regions. Readers are advised not to attempt access to the mining areas unless accompanied by a guide well versed in local conditions.

GEOLOGY, FORMATION, AND OCCURRENCE

Opal is silicon dioxide with water, with the general formula $SiO_2 \cdot nH_2O$. Silica actually represents 85%–90% of the composition of opal. Scanning electron microscope studies of gem opal have shown that the phenomenon called play-of-color is the result of a regular arrangement of silica spheres that form a sort of honeycomb pattern, with uniform gaps between the spheres. These gaps create a three-dimensional diffraction grating (Darragh and Sanders, 1965), and variations in the sizes of spheres and gaps result in different colors. Evidence suggests that these spheres form and accumulate by colloidal aggregation. The essential preconditions for the formation of these grids are: (1) a clean silica solution, (2) an undisturbed cavity in which the solution can accumulate, and (3) time for water to evaporate and the spheres to line up at the bottom of a cavity (Darragh et al., 1976).

The vast majority of Australian opal formed under very specialized conditions from aqueous silica gels derived from the intense weathering of feldspathic sedimentary rocks under the action of percolating groundwater. In Queensland, gem-quality opal occurs erratically within the Winton formation. Before 1964, no systematic geologic work had been carried out in the Winton area. Jackson (1902) described opal workings at Opalton, and Cribb (1948) reported on opal production at Hayricks. In 1964, however, the Manaroo sheet, an area that includes the Winton formation, was mapped and was subsequently described by Jauncey (1967). More recently, the geology of these opal deposits has been discussed in detail by Senior et al. (1977) and summarized by the Queensland

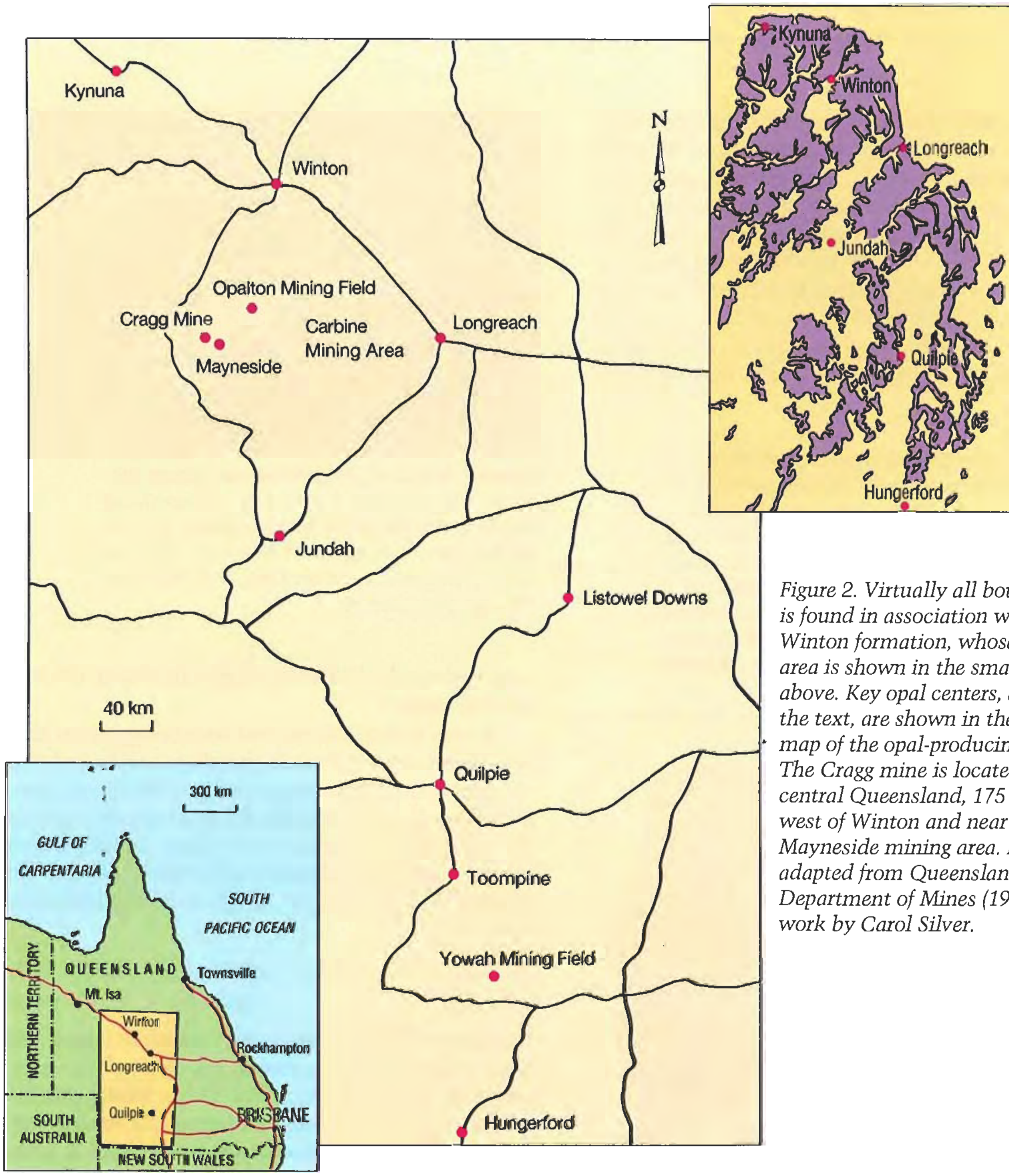


Figure 2. Virtually all boulder opal is found in association with the Winton formation, whose outcrop area is shown in the small map above. Key opal centers, as noted in the text, are shown in the larger map of the opal-producing area. The Cragg mine is located in west-central Queensland, 175 km south-west of Winton and near the Mayneside mining area. Maps adapted from Queensland Department of Mines (1988); art-work by Carol Silver.

Department of Mines (1988) and Keller (1990); these references have been used extensively in the following summary.

The Winton formation extends from the southern border of Queensland northwest to the vicinity of Kynuna (again, see figure 2). The feldspathic sandstones, siltstones, and mudstones that comprise the Winton formation first accumulated during Cretaceous times, about 80–100 million years (My) ago, when a shallow inland sea—the Great Artesian Basin—occupied much of central Australia. During the latest Cretaceous to Eocene time (70–50 My ago), after the basin's rocks had been uplifted, a tropical climate produced the first of two periods of intense chemical weathering. This first period resulted in the formation of the Morney profile, a three-layered weathering sequence more than 90 m thick (figure 3). In this profile, an upper siliceous zone overlies a varicolored zone which, in turn, overlies a basal ferruginous zone. Ironstone concretions (composed chiefly of goethite, limonite, and hematite; Senior et al., 1977) formed in the basal ferruginous zone from iron oxides that had been chemically leached from the overlying rocks. Subsequently, drainage patterns developed, followed by sedimentation along the river systems, and minor erosion of the Morney profile occurred in certain areas.

A second chemical-weathering event in the late Oligocene (about 25 My ago) resulted in the formation of the morphologically distinct, four-layered Canaway profile (again, see figure 3). This later formation consists of an indurated, highly kaolinitic crust over a mottled zone that grades down into varying thick-

Figure 3. Two weathering profiles characterize the Winton formation: (left) the Morney profile, which consists of three layers of approximately equal thickness (more than 90 m total) and was formed 50–70 million years ago; and (right) the Canaway profile, which consists of four layers of unequal thickness (a maximum of 45 m total) and formed about 25 million years ago. Note that the vertical scales for the two profiles differ; see text for further details. After Senior et al. (1977).

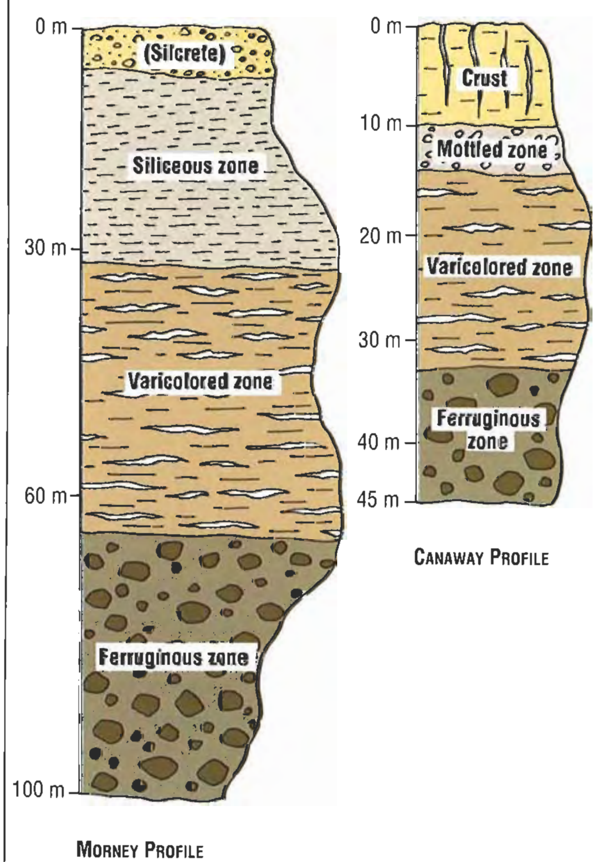


Figure 4. Just as it precipitated throughout the Winton formation, opal can be seen here filling cracks and voids in the host ironstone. Specimen is approximately 75 mm × 28 mm wide. Photo by Rudy Weber; © Australian Opal and Gemstone Photographic Library.

nesses of residual Morney profile; in places, the two profiles merge.

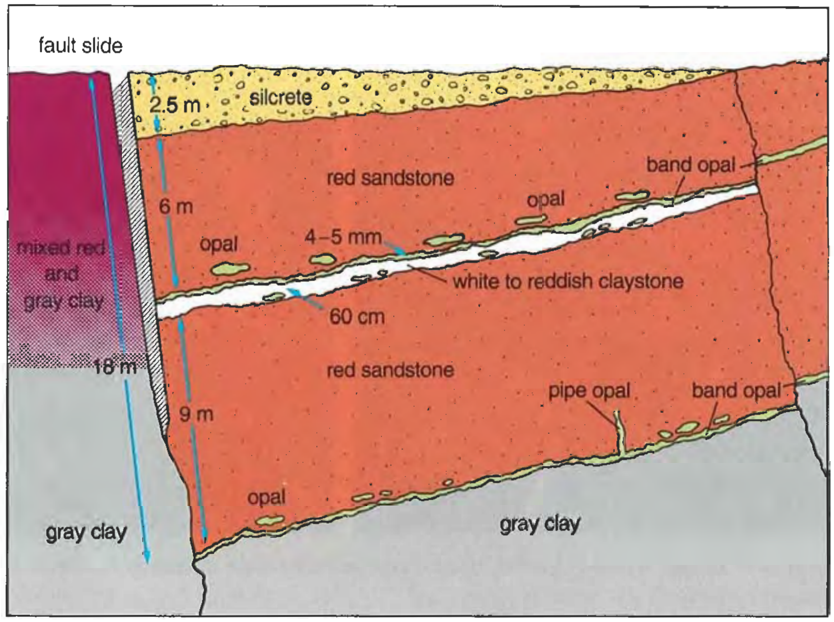
It was during this second weathering event that opal began to precipitate in shrinkage cracks and other voids within the ironstone bodies of the Morney profile (figure 4). Erosion of the feldspathic sediments in the upper siliceous zone of the Morney profile began breaking down the feldspar into kaolinite, which then released silica in solution, as shown by the following equation:

$$\underset{\text{(feldspar)}}{2KAlSi_3O_8} + H_2CO_3 + H_2O \longrightarrow \underset{\text{(kaolinite)}}{Al_2Si_2O_5(OH)_4} + K_2CO_3 + \underset{\text{(silica)}}{4SiO_2}$$

The silica solution subsequently migrated downward in groundwater as an aqueous gel, often along lineaments or smaller faults called slides, which provide natural pathways through nonpermeable or semi-permeable strata. The gel eventually precipitated in voids in the ironstone, in those localities where weathering and erosion had removed enough of the older, Morney profile to bring the basal ferruginous zone to within 40 m of the surface. A fluctuating water table, with periods of downward infiltration and upward evaporation of groundwater, was also critical for the deposition and dehydration of the silica gel, respectively. The opal accumulated slowly, the product of many successive cycles of saturation and dehydration. In fact, the voids in some boulders are only partially filled with opal because the process stopped. Winton opal is believed to be between 15 and 32 My old (Senior et al., 1977).

In the area of the Cragg mine, opal is commonly found at the base of red (ferruginous) sandstone layers

Figure 5. This idealized cross-section shows the various layers in which opal has been found in the Winton district, where the Cragg mine is located. Drawing by Richard Wise; after V. Evert and J. Evert (pers. comm., 1990–1993). Artwork by Carol Silver.



at a depth of no more than 20 m from the surface (V. Evert, pers. comm., 1993; see figure 5 for an idealized diagram of the occurrence of opal in this region). The sandstone is usually overlain by a silcrete cap (soil, sand, and gravel cemented by silica) that is called "shincracker" by local miners; in some areas, a collapsed silcrete overburden may merge laterally into red sandstone at a slide. Often an underlying layer of white fine-grained claystone forms the lower limits of the opal deposits. However, miners sometimes encounter a false bottom—that is, a layer of white to reddish claystone 15–60 cm (6–24 in.) thick—which covers a second red sandstone layer that may be opal bearing. Opal may also occur within the "false bottom." Once a second layer of pink, lateritic sandstone is encountered, however, downward mining is stopped.

In this part of Queensland, opal is typically found in horizontal bands between layers of ironstone, at the point where sandstone meets clay. Often the opal seam is split, and both halves of the "split" are polished for jewelry (figure 6). Opal-bearing ironstone nodules (figure 7)—some more than 30 cm (12 in.) in diameter—may also be found at the base of a slide or within a claystone layer. However, Queensland opal is also found in pipes (long, stick-like structures) and seams in sandstone, as well as in sandshot (sand mixed with opal) layers or in ironstone nodules with a sandstone core. Note that the finest color is usually found at the bottom of the seam or void, in the material that precipitated earliest (G. Brooks, pers. comm., 1993).

At the Cragg mine, most of the opal is found where sandstone meets clay, with more being trapped in the sandstone than in the clay (V. Evert, pers. comm., 1993). The ironstone "boulders" at Cragg are composed of concentric bands of hydrated iron oxide (again, see figure 6). The seams of band opal found there are typically only 4–5 mm thick, but at least one band 25 cm thick has been recovered. At Cragg, as elsewhere in Queensland, the upper surface of the seam may have rounded botryoidal protrusions called "nobbies" up to a few centimeters in diameter (QDM, 1988).

Note that the term *boulder opal* is typically applied only to opal deposited in veins or pockets, or between concentric bands of hydrated iron oxide, in ironstone concretions—not to opal that forms in sandstone or in more unusual forms such as filling cracks in petrified wood. Even if the opal originally formed on an ironstone base, if it is thick enough to produce cabochons without supporting matrix, by definition it is not called *boulder opal*.

PROSPECTING AND MINING

Opal prospecting has changed little since the 1880s. Despite the Australian government's experimentation with aerial and satellite photography, prospecting is still largely a hit-or-miss affair, with miners relying mainly on surface indicators (e.g., geobotanical exploration) to determine likely deposits (V. Evert, pers. comm., 1993).

Areas at the bases of buttes and areas with dark red sandstone are believed to have good potential. In addition, prospectors look for certain species of trees that historically have been associated with opal. For example, malleebush trees grow in red sandstone; and

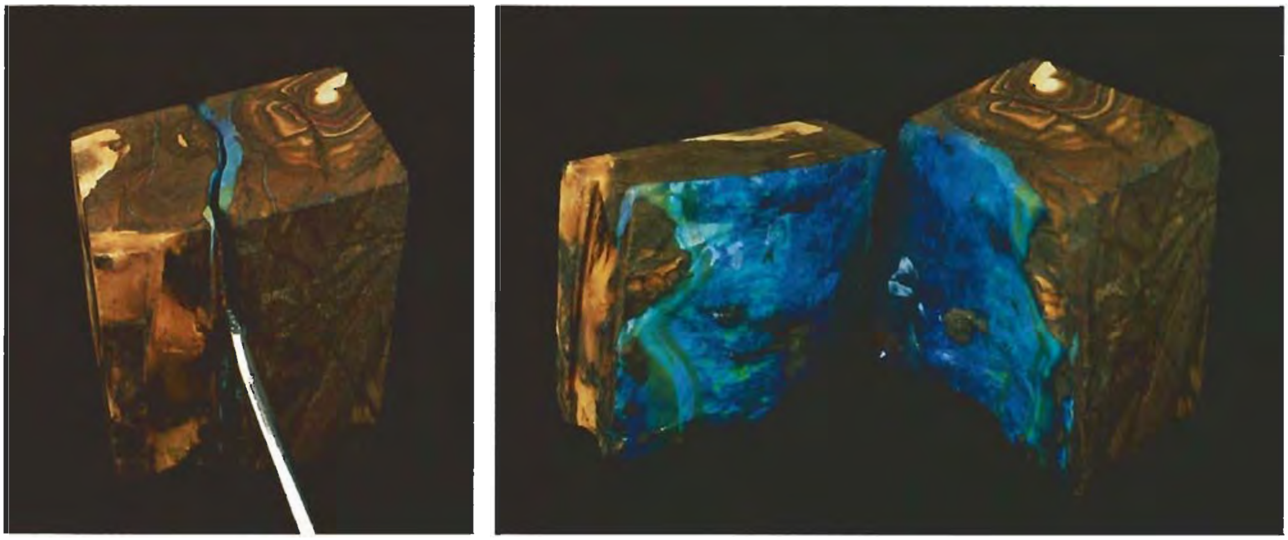
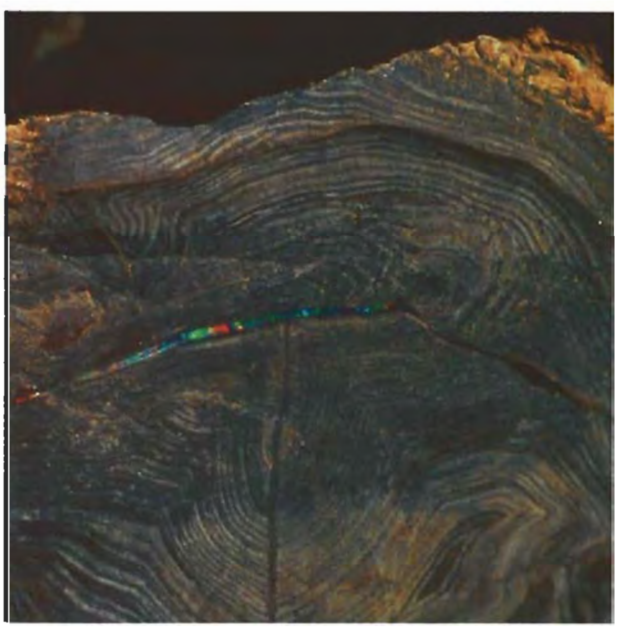


Figure 6. In the Winton district, opal is commonly found in bands between layers of ironstone (left). To recover the opal, the seam is often "split" (right), with both halves potentially useful for jewelry. Photos by Rudy Weber; © Australian Opal and Gemstone Photographic Library.

lapinga trees, which have deep roots, tend to cluster along lineaments and slides. Both are considered good indicators of opal mineralization. Even so, as noted above, most current opal production is in or adjacent to areas originally discovered and worked in the 1880s (V. Evert, pers. comm., 1993).

Figure 7. Opal-bearing ironstone nodules are common throughout Queensland, with the opal often trapped within concentric bands of hydrated iron oxide. Photo by Rudy Weber; © Australian Opal and Gemstone Photographic Library.



Today, most mining operations in Queensland, including the Cragg mine, are mechanized. According to the Queensland Department of Mines, as of December 1992 Queensland mines averaged three miners for each machine, with 41 machines and approximately 123 people currently working the opal fields.

Although there is some tunneling to mine for opal in Queensland, the Cragg operation—like most mines in that area (the author visited four other sites around Mayneside)—is open cut. First, a truck-mounted auger drills a hole 75 cm (30 in.) in diameter and up to 20 m deep, through layers of silt, sandstone, and claystone (figure 8). If signs of opal are found, a crew member is lowered by rope to check for traces of "color." Once an opal-producing area is located, a bulldozer carefully cuts open a section of ground, removing overburden down to the opal-bearing stratum. A cut will be at least 60 × 15 m (about 200 × 50 ft.), usually with a depth between 2.5 and 12 m (8 and 40 ft.), depending on the depths of the different strata (figure 9). As opal is encountered, the shape of the pit is altered to follow the opal run. While the bulldozer opens the cut, another crew member walks behind it, scanning for nodules. Miners must be alert, as color is not immediately evident in many gem-grade nodules (figure 10). Modern mining is very different from the methods of the 1890s, when prospectors with colorful names like Jundah Jack and Silk Shirt Joe roamed the outback with little more than their swag and tucker, a pick, and a shovel.

Of the opal produced to date at the Cragg operation, approximately 90% has been ironstone boulder, 8% sandstone "boulder," 1.5% ironstone matrix (e.g., band opal), and 0.5% pipe opal. The largest opal that has been found at Cragg is a piece of band opal approximately 1 m × 60 cm × 25 cm thick (3 ft. × 2 ft. × 10 in.), which was uncovered in 1987. Several gem-quality cabochons were cut from this piece (V. Evert, pers. comm., 1993).

VISUAL APPEARANCE AND GEMOLOGICAL PROPERTIES

As previously stated, boulder opal has a singular appearance that makes it easily separated visually from other types of opal. Simply stated, polished boulder opal—by definition—will always contain some ironstone as part of the finished gem. Cut boulder opal is usually divided into two types: (1) opal *with* matrix—that is, a thin layer of gem opal overlying an ironstone back that is not visible faceup (figures 1 and 11); and (2) opal *in* matrix—that is, where parts of the host ironstone are visible in the faceup portion of the gem (figure 12). Many seams of boulder opal are so thin that more than half of the finished gem is matrix.

Most boulder opal from the Cragg mine has a dark brown or black background (figure 13). The dark color is caused by a thin, sometimes microscopic layer of black potch (nongem) opal sandwiched between the ironstone matrix and the translucent layer of gem

Figure 9. Open-cut operations at the Cragg mine have exposed these layers of lateritic sandstone and claystone, which are typical of the Winton district. Photo by Andrea Williamson.

Figure 8. To locate opal at the Cragg mine, a large truck-mounted augur drills as deep as 20 m to remove samples of the various levels in search of signs of opal. Photo by Richard Wise.

Figure 10. This nodule is typical of those recovered from the Cragg mine. Only a small portion of the nodules are opal bearing, and many of those that contain gem opal do not show color until they are cleaned or cracked open. Photo by Andrea Williamson.

opal (P. Downing, pers. comm., 1993). However, the background color of Queensland boulder opal may also be gray, brown, orange, or even white (Downing, 1992). The dark-hued stones known as "boulder blacks" normally appear to have the most intense, highly saturated play-of-color, because the dark background contrasts with the phenomenal colors of the gem material. The predominant phenomenal colors in gem-quality Queensland boulder opal are intense hues of red, blue, and green (Senior et al., 1977). Stones from the Cragg mine follow this pattern (again, see figure 13), although red and green predominate.

The author recorded the gemological properties of five cabochons of opal with matrix from Queensland, which weighed 1.42 to 6.54 ct (note that because of the varying amounts of matrix that may be present, boulder opal is usually sold by the piece rather than by weight). Spot refractive-index readings, taken with a Duplex II refractometer with a monochromatic light source, were consistently in the 1.42–1.43 range, or approximately 0.02–0.03 below the average reading expected of opal (1.45; Liddicoat, 1990) and toward the low end of its possible (1.40–1.50) range. All of the samples were inert to both long- and short-wave ultraviolet radiation. Because of natural variations in the ironstone:opal ratio from one cabochon to the next, specific-gravity measurements would not be useful and therefore were not taken.

Figure 11. In fine boulder opal with *matrix, the matrix provides the backing for the opal but is not visible faceup. This 19 × 12 mm opal with matrix is accented by yellow diamonds and tourmalines. Jewelry designed and executed by Laurie M. Donovan; courtesy of L. & R. Wise, Goldsmiths. Photo © GIA and Tino Hammid.*

Figure 12. In boulder opal in *matrix, parts of the host ironstone are visible in the faceup portion of the gem—often, as illustrated here, enhancing the overall composition of the piece. Note that these two opals (each approximately 10 × 30 mm) are actually halves of the same "split." Jewelry courtesy of Nanette Forester, American Lapidary Artists, Los Angeles, CA; photo © Harold & Erica Van Pelt.*

AESTHETICS AND QUALITY EVALUATION

Judging the quality of opal—and particularly boulder opal—is in some ways simple and in others difficult. It is simple because, in the words of one prominent dealer, "the brighter it is, the better it is." In more technical terms, color saturation or intensity is the main criterion for evaluation (Wise, 1991). Two additional criteria are common to all types of opal: color and pattern (see, e.g., O'Leary, 1977; Downing, 1992).

Most experts feel that a top-grade stone must be a multicolor, that is, display three or more colors. In addition, some colors are considered more desirable than others, with red at the top of the list. For example, In *Gemworld Pricing Guide* (1991), author R. B. Drucker reserves his highest rating for a stone that shows 75% red plus two additional colors (see, e.g., figure 14). Among the great variety of patterns in which the play-of-color appears, harlequin (a display of medium-to-large angular blocks of color; see, e.g., figure 15) is often considered the most valuable, and pinfire (a pattern of tiny points of color) is usually the least. The difficult part of judging boulder opal, specifically the opal-in-matrix type (ironstone visibly mixed with opal), is an additional factor that might best be termed *composition*.

In the evaluation of boulder opal, composition refers to the overall distribution of visual elements. Because composition is qualitative, it is also subjective. It is tempting to reduce the relative size, shape, and juxtaposition of opal and ironstone to a question of "flaws": that is, the greater the proportion of matrix, the poorer the quality of the gem (Downing, 1992). However, the dramatic increase in popularity of boulder opal in recent years is due in part to increased interest by designers and craftspeople who have been drawn to the painterly qualities of this Queensland gem. They view and value the stone much as a critic views a painting—as a balanced combination of elements.

The total composition of opal and matrix should, like a good abstract painting, be pleasing to the eye. For example, a squarish cabochon with small splashes of

Figure 13. Cragg-mine boulder opal, like these two pieces (19 mm and 14 mm in longest dimension, respectively), usually has a dark brown or black background. Note also the intense green, blue, and red play-of-color displayed. Jewelry by John Iskendrian; courtesy of Boulder Opal Enterprises, Winton, Qld., Australia; photo by Doug Drummond.

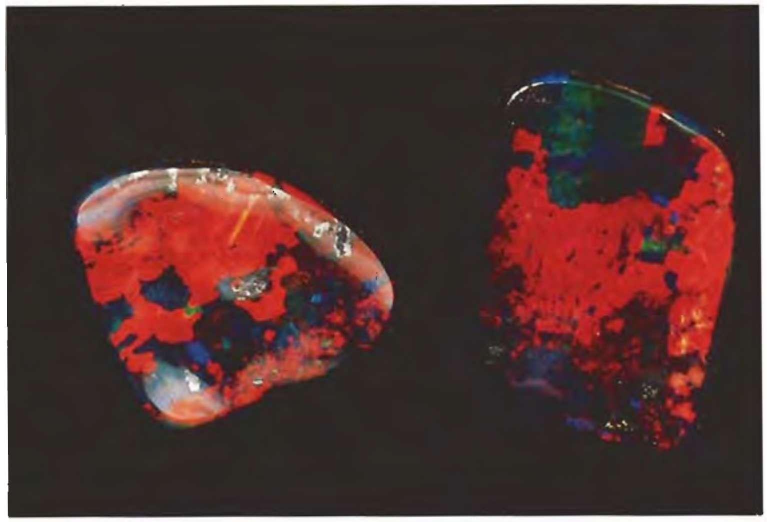


Figure 14. These two samples of boulder opal show the highly saturated, predominantly red play-of-color (with some blue and green) that is favored by many opal enthusiasts. Photo by Rudy Weber; © Australian Opal and Gemstone Photographic Library.

Figure 15. Large, angular patches of color characterize the boulder opals on the left and right as harlequins; the stone in the center shows pinfire play-of-color. The composition of all three is attractive. Courtesy of the Weber Karl Lehman Collection; photo by Rudy Weber; © Australian Opal and Gemstone Photographic Library.

color only at the corners may appear unbalanced and unattractive, whereas gems with a major portion of color toward the center (again, see figure 12) will generally be attractive. Occasionally one sees fashioned matrix opal—a stone that is primarily composed of matrix with bright flashes of opal throughout. As boulder opal is often cut freeform, the overall shape of the stone is also important.

DURABILITY

Boulder opal has a reputation for durability. Samples of opal with matrix and opal in matrix obtained by the author from the Cragg mine have been on constant display under high-intensity jewelry store lights for approximately two years with no evidence of cracking or crazing. However, another boulder matrix specimen, purchased in the rough by the author at Opalton, 32 km northeast of Cragg, initially showed intense fiery veins of opal that turned opaque white within days after the stone was set. This phenomenon, called cottoning, has been reported previously in Queensland boulder opal (Loneck, 1986).

Because of its generally high degree of stability, boulder opal from Queensland is believed to be lower in water content than opal from other parts of the continent. Shrinkage and cracking are virtually unknown (Senior et al., 1977), especially in the boulder blacks. "Lifting" (whereby the opal layer detaches itself from the matrix backing) is reported in approximately 2% of the material mined at Cragg; a thin layer of gypsum between the ironstone and opal layers causes the separation (J. Evert, pers. comm., 1993). Other cutters have reported lifting in 4%–5%, and crazing in approximately 6% (predominantly in the white opal) of Queensland stones (George Brooks, pers. comm., 1993).

SIMULANTS AND TREATMENTS

The most common boulder-opal simulants encountered in the trade are doublets of ironstone topped with a thin layer of opal. Usually this simulant is easily distinguished from natural boulder opal by the very straight dividing line between the top and bottom layers, although occasionally doublets with a natural-appearing undulating join between opal and matrix are seen. While such doublets can fool even experts if examined only with the unaided eye, close examination of the seam under low magnification will reveal a thin line of epoxy—commonly dyed to resemble the ironstone—that sometimes contains spherical cavities, probably the remains of gas bubbles (figure 16; Fryer, 1982). Although a thermal reaction tester will cause the cement layer to flow, this test is emphatically *not* recommended because of opal's extreme sensitivity to heat. Boulder opal is readily separated from treated Andamooka matrix opal by the presence of the black particulate carbon impregnator in the treated material, which can be seen at 10× magnification (see Brown, 1991).

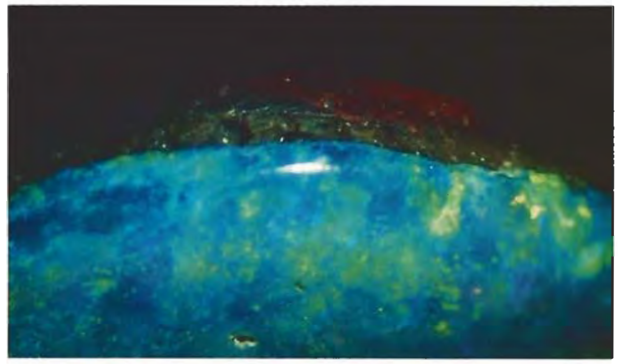


Figure 16. The most common simulant of boulder opal is manufactured by "cementing" a thin layer of opal to an ironstone backing. In the stone shown here, hemispherical cavities, probably formed by gas bubbles, reveal the thin line of epoxy that joins the two materials. Photomicrograph by Robert E. Kane; magnified 12×.

MANUFACTURING AND DISTRIBUTION

Opal manufacturing in Queensland is very much a cottage industry. No operations in the state are known to survive from income generated by cutting alone (PGIQ, 1992). Because opal mining is so expensive, most operations in Queensland are vertically integrated. To maximize their profits from the rough material, mine owners typically have in-house cutting facilities and very often their own wholesale and/or retailing operations as well. While this situation assures domestic supplies and allows much greater local control over prices, it may limit exportable supplies in times of slow production.

The distribution of boulder opal is, therefore, entirely in the hands of private miners and cutters. In 1988–89, exports of cut Queensland boulder opal totaled Aus$11,606,000 (US$8,766,012); they grew to Aus$12,074,000 (US$9,526,386) in 1989–90 (ABS, 1992). Miners report that demand for boulder opal remained strong through most of 1991 (Wise, 1991).

As of late 1992, the newly formed Queensland Boulder Opal Association (QBOA) had scheduled a series of "trade only" auctions to take place in the town of Winton during May, July, August, and October of 1993. In the past, visiting dealers have had to travel long distances between the fields and local trading centers to seek out miners and cutters and then arrange purchases. The auctions should act to centralize buying, stabilize prices, and expedite trading (QBOA press release, 1992).

FUTURE PRODUCTION

With the advent of mechanized mining, exploration and production costs have soared. Heavy equipment, fuel, and water must be trucked over long distances in an isolated and hostile environment. These factors have placed great stress on opal-mining operations during periods of economic recession. However, the vast size and unexplored potential of the Winton formation should assure significant production into the foreseeable future.

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