UPDATE ON AMMOLITE PRODUCTION FROM SOUTHERN ALBERTA, CANADA

Keith A. Mychaluk

There have been a number of changes in Ammolite production from southern Alberta, Canada, since 2001. Korite International continues to be the dominant supplier, with a 40% increase in finished-stone production during this period. As mining focuses on Zone 4 of the host Bearpaw Formation, Korite's inventory has changed from predominantly fractured to sheet Ammolite. The Aurora Ammolite mine, operated by Rusty Pimm Enterprises, is the only other fully mechanized open-pit mine, but artisanal miners continue to be active. Dinolite—Ammolite combined with siliceous dinosaur bone—has been introduced as yet another innovative use for Ammolite.

Significant changes have occurred in the mining of Canadian Ammolite since 2001 (see Mychaluk et al., 2001), with new producers and new mines emerging. The growing industry continues to yield material for both the jewelry and specimen-collector markets (e.g., figures 1 and 2). This contributor visited the main Ammolite-producing area southwest of Lethbridge, Alberta, in September 2008 and conducted several interviews with producers through early 2009. Currently, the two main producers are Korite International and the Aurora Ammolite mine, with continuing activity by artisanal miners. In addition, a new product, Dinolite, in which Ammolite and other gem materials are combined with dinosaur bone fragments, has been introduced.

See end of article for About the Author and Acknowledgments.
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ABOUT AMMOLITE

Ammolite is a gem material composed of aragonite that is derived from the shells of ammonites, extinct cephalopod mollusks found in marine sediments of the Bearpaw Formation (Fm) in southern Alberta, Canada. As reported in Mychaluk et al. (2001), commercial quantities of Ammolite are derived from two ammonite species (*Placenticeras meeki* and *P. intercalare*) from specific horizons within the Bearpaw Fm shale in the St. Mary River valley southwest of Lethbridge, Alberta (figure 3). Only two such horizons—labeled by Korite International as *K Zone* and *Zone 4*—are rich enough to sustain exploitation by open-pit mining methods. Ammolite can be grouped into two categories based on physical appearance: *fractured* and *sheet* (again, see figure 1). In fractured Ammolite, the original ammonite shell has been crushed and healed by natural processes, creating a "stained glass window" appearance. Fractured Ammolite is typically associated with the K Zone. Little or no crushing of the ammonite shell has occurred in sheet Ammolite; it is typically sourced from Zone 4.

MINING AND PRODUCTION

Korite International. The dominant Ammolite producer continues to be Korite International of Calgary, Alberta. As discussed by Mychaluk et al. (2001), Korite has operated several open-pit mines to recover both gem-quality Ammolite and complete ammonite fossils from the Bearpaw Fm. Pierre Paré, president of Korite, provided much of the following update on their activities.

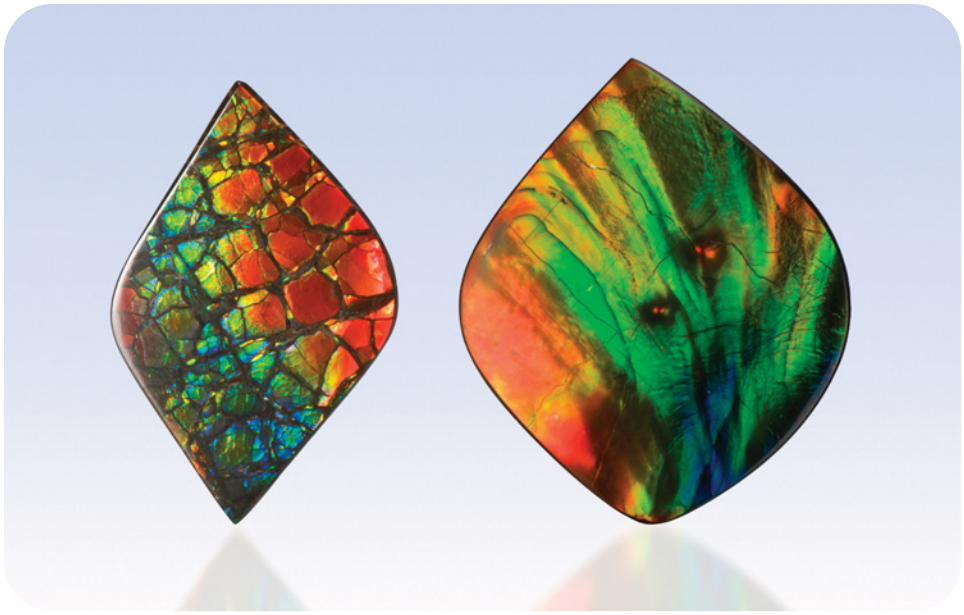


Figure 1. Alberta's St. Mary River valley continues to produce high-quality Ammolite. While fractured Ammolite (left, 4.7 × 3.0 cm) was mainly exploited in the past, today's production is dominated by sheet Ammolite (right, 5.2 × 4.4 cm). Courtesy of Korite International; photo by Robert Weldon.

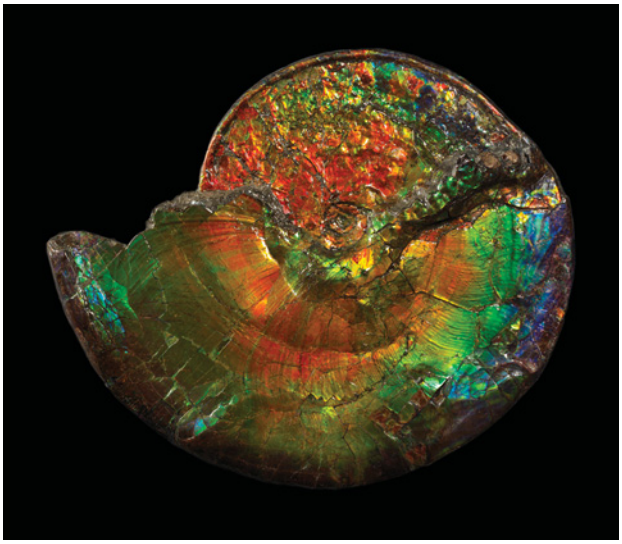
The Kormos mine, the first major producer (opened in 1983), has not been reactivated since its suspension in 1994. The Oxbow mine was first opened in 1994, and exhausted by the spring of 2001. A total of 11 hectares were excavated to a maximum depth of 20 m, the economic limit of recovery. The mine exploited the "K Zone" horizon of the Bearpaw Fm, producing predominantly fractured Ammolite.

Excavation at the Zone 4 mine began in late 2000, and the economically productive portion of the deposit was exhausted in October 2003. A total of 5 hectares were exploited and, as the name implies, the mine targeted the Zone 4 horizon of the Bearpaw Fm, which primarily contains sheet Ammolite. By November 2004, both mines were totally reclaimed, with the original stockpiled topsoil backfilled and seeded with native grasses.

Korite commissioned two new open pits near the Zone 4 deposit: the Salberg and Power Pole mines. These also target Zone 4 of the Bearpaw Fm. Mining at Salberg started in 2004, but the pit was reclaimed in 2008 after yielding only 3 hectares of economical deposits. The Power Pole mine was also started in 2004, and since then approximately 5.5 hectares have been mined. Currently, this is the only active Korite mine site, although production was suspended between December 2008 and mid-July 2009 due to an unusually cold winter and the economic downturn. Korite claims that test holes on the Power Pole property indicate sufficient reserves for more than a decade of reliable production.

Of significant note is the production shift from fractured Ammolite to sheet Ammolite since 2001. As stated in Mychaluk et al. (2001), in 1999 Korite manufactured 57,025 finished gemstones from rough material derived primarily from the now-abandoned Oxbow mine. Ammolite recovered from the Oxbow mine was mostly fractured because it was produced from the K Zone of the Bearpaw Fm. Now that

*Figure 2. Intensely colored fossil ammonite specimens are recovered from the Ammolite deposits. This 60-cm-diameter ammonite (*P. meeki*) was donated to the American Museum of Natural History in New York by Korite International and Canada Fossils Ltd. Courtesy of AMNH; photo by Craig Chesek.*



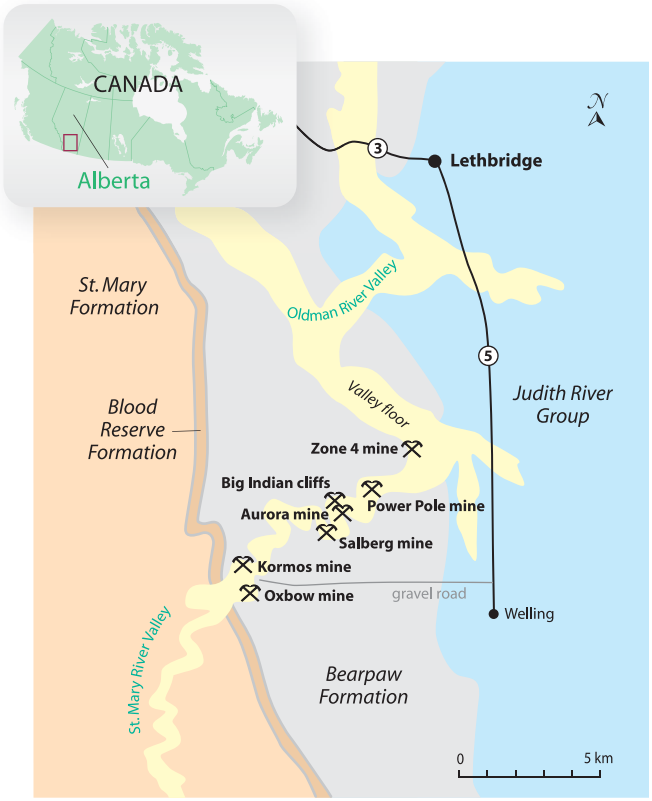


Figure 3. This map shows both the locations and subsurface bedrock of the main Ammolite-producing mines and collecting areas near Lethbridge, Alberta. Ammolite is only recovered from marine shale of the Cretaceous Bearpaw Fm. Modified from Mychaluk et al. (2001).

mining is focused on the Zone 4 horizon, Korite reports that 95% of the finished gemstones produced in 2008 were sheet Ammolite. In 2008, Korite manufactured 77,110 assembled stones (triplets) and 2,752 stabilized solids (including very few doublets) for a total of 79,862 finished gemstones. As Korite continues to be the dominant producer of Ammolite worldwide, the vast majority of Ammolite seen in today's market has switched from fractured to sheet during this decade. Korite reports, however, that it has enough stockpiled fractured Ammolite to produce 2,000–3,000 finished gemstones, to accommodate future demand for this material.

The greater availability of sheet Ammolite has helped grow the market, according to Korite, because this material tends to have stronger iridescence and more of the popular blue coloration than the fractured material. Korite, in fact, claims that revenue from Ammolite sales grew by more than 130% from 2001 to 2008. Sales in Asia (mainly Singapore, Hong Kong, China, and Japan) have grown three-fold since 2001. Much of this growth is from those practicing the ancient Chinese system of *feng shui*. These customers are reportedly purchasing more Ammolite gemstones as well as ammonite fossils because the colors and shell shape of these materials are symbolic and auspicious in the *feng shui* tradition. Korite has opened further markets for Ammolite through the cruise ship industry.

Korite's sister company, Canada Fossils, has discovered some significant fossils (*Placenticeras meeki*) in the new Salberg and Power Pole mines. Korite donated an exceptional specimen to the American Museum of Natural History in New York in 2007; it is on display in the museum's "Grand Gallery" (again, see figure 2).

Due to the size of Korite's operation in the marine sediment of the Bearpaw Fm, the chances of finding Cretaceous-age marine reptile skeletons are quite good. Since 2001, Korite has unearthed three mosasaurs and one plesiosaur at its Salberg and Power Pole mines. These specimens are among the best preserved from Alberta. The fossils excavated were turned over to the Royal Tyrell Museum of Paleontology in Drumheller, Alberta, where they are being restored and studied.

Aurora Ammolite Mine. Located within the St. Mary River valley between Korite's Salberg and Power Pole mines, the Aurora is the only fully mechanized Ammolite mine not operated by Korite. Owner Rusty Pimm took the author on a tour of this open-pit mine in September 2008 (figure 4). First opened in 2004, the pit is slightly larger than 1.2 hectares and has been excavated to a depth of 18 m (60 ft) on the west end and to 12 m (40 ft) on the east. The pit is being expanded (along strike) to the south and is being backfilled and reclaimed as mining moves southward. Reserves appear to be significant. The author believes the Aurora mine is exploiting Zone 4 of the Bearpaw Fm based on pay zone thickness (~1.5 m), proximity to Korite's new mines, relative stratigraphic position within the Bearpaw Fm, and the production of sheet Ammolite.

Mining is done by a two-person team (Rusty's sons) consisting of a backhoe operator and a "spotter" (see Mychaluk et al., 2001, for more on Ammolite mining techniques). The Bearpaw Fm shale, fortunately, is quite friable above the pay zone, while it is hard and sandy below this horizon.

The Aurora mine operated for a total of 40–60 days in 2007, mainly in the summer months, while Korite's operations are typically year-round. The 2008 season was much shorter than previous years due to heavy rains in June that flooded the Aurora pit and

required pumping before operations could resume.

Highly localized faulting within the Bearpaw Fm has created a number of hazards at the Aurora mine. Shortly after a fault with 4.5 m (15 ft) of displacement was exposed, a significant pit-wall collapse occurred. Although no one was injured, some minor equipment was buried and the pit had to be cleaned out. The faults are also problematic because they alter the depth at which the pay zone is located, thereby increasing mining time and cost. Most significantly, they serve as conduits for water percolation from the surface into the pay zone, causing damage to the Ammolite within (e.g., iron-oxide staining). The faults may have formed when the weight of overlying glaciers caused the Bearpaw shale to buckle during the last ice age.

Within the pay zone, four to five complete ammonite fossils (generally situated horizontally and compressed laterally) are found per backhoe set (defined as the volume a backhoe can excavate from one set location). Rough material is sent to Edmonton, Alberta, for manufacture into gemstones (eventually marketed by Aurora Canadian Jewelry) or for restoration into display specimens.

Artisanal Mining. Surface collecting of Ammolite (and complete ammonite fossils) has been ongoing since the late 1960s, but some localities are more challenging to access than others. Tom Chant—president of Enchanted Designs, an independent manufacturer of Ammolite jewelry—purchases much of his rough material from members of the Blood Indian Tribe who collect from the west banks of the St. Mary River (located on reservation lands opposite Korite and Rusty Pimm's operations). Mr. Chant arranged a tour for the author of a key collecting area with Edward "Ed" Eaglechild of the Blood Tribe. The site, locally called "Big Indian" or "Kings," is an imposing 80 m (260 ft) high cliff overlying the St. Mary River (figure 5).

Mr. Eaglechild and other freelance collectors like him rappel down these cliffs, swinging back and forth along the face at various levels in search of Ammolite and complete fossil ammonites. The ropes are either tied to the axle of a truck or to metal stakes driven deep into the ground at the top of the cliff. Mr. Eaglechild has been collecting for over nine years, and reported that there are many individuals and groups from the Blood Tribe who are involved in artisanal mining–based businesses (such as Raw Ammonite, Black Horse Mines, and Buffalo Rock Mining Co.). Most collecting is weather dependent and usually performed during the summer, but he stated that he was one of two collectors who worked through the Canadian winter last year. He typically collects five times per week and finds, on average, one good-quality fossil ammonite (sometimes with Ammolite attached) per day. Mr. Eaglechild reported that there are six productive cliff areas on the Reserve including Big Indian. The exposed surface area of the cliffs is significantly larger than that of the open-pit mines and, when combined with high erosion rates, yields a con-

Figure 4. Outside of Korite International, only newcomer Rusty Pimm Enterprises has been successful at continuous mechanized mining for Ammolite. In this view, looking west, topsoil can be seen stockpiled on the north and west sides of the pit. Photo by K. Mychaluk.

Figure 5. The cliffs at Big Indian can only be accessed by Blood Indian Tribe members. The top buff layer consists of glacial lake sediments, which overlie weathered Bearpaw Fm shale (light brown). The majority of the cliff face exposes unweathered gray Bearpaw shale that hosts Ammolite and ammonite specimens. View is upstream to the southwest. Photo by K. Mychaluk.

Figure 6. Dinolite is a composite of Alberta dinosaur bone and Ammolite with sugilite, turquoise and/or malachite, as seen in these pendants (22 × 32 mm on the left). Courtesy of Enchanted Designs; photo by Robert Weldon.

sistent supply of material to collect. The author was also shown two pits on the Blood Reserve that had formerly been excavated with mechanical equipment. Results and production history were not provided, and other such pits may also exist. Additional photos are available in the G&G Data Depository at www.gia.edu/gandg.

Rough production from the Blood Tribe is typically sold to Enchanted Designs and Korite, although there are many other small buyers and jewelry manufacturers in the area.

FOSSIL POACHING

Theft (locally called "fossil poaching") continues to be a problem for all mine operators. Shortly before the author's field visit, burglars had cut locks and gained access to a field office at the Aurora mine. The Ammolite miners interviewed report that, as a matter of policy, they remove all gem material (including high-quality fossil specimens) from their mine sites at the end of each day. As a further deterrent, miners routinely comb their pits and exposed outcrops for any trace of Ammolite regardless of quality. As erosion rates of the Bearpaw Fm are quite fast, most operators typically scour these surfaces on a daily basis. Korite also conducts truck patrols to dissuade would-be thieves. During the author's one-day visit, a Korite vehicle was observed intercepting trespassers on two occasions. Thieves are also active at night, when they make small excavations.

DINOLITE

Lapidaries continue to find innovative ways to use Ammolite. Due to its typically thin and sheet-like nature, Ammolite has been used in mosaics, such as on watch faces. Enchanted Designs manufactures two products in which Ammolite is used in a mosaic or composite fashion. Keeping with a Canadian theme, one product consists of polished mammoth ivory pieces from the Yukon Territory inlaid with Ammolite and other gem materials such as turquoise or sugilite. The other, a new product called "Dinolite," combines siliceous dinosaur bone fragments from Alberta with pieces of Ammolite, sugilite, turquoise, and malachite using an undisclosed process (figure 6). The Canadian Intellectual Property Office granted trademark status to Dinolite on July 23, 2008.

CONCLUSION

Production of Ammolite has grown significantly since 2001. Notwithstanding the current global economic slowdown, the author predicts this trend will continue for the next decade.

ABOUT THE AUTHOR

Mr. Mychaluk (kmychaluk@shaw.ca) is a geologist in Calgary, Alberta, Canada.

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