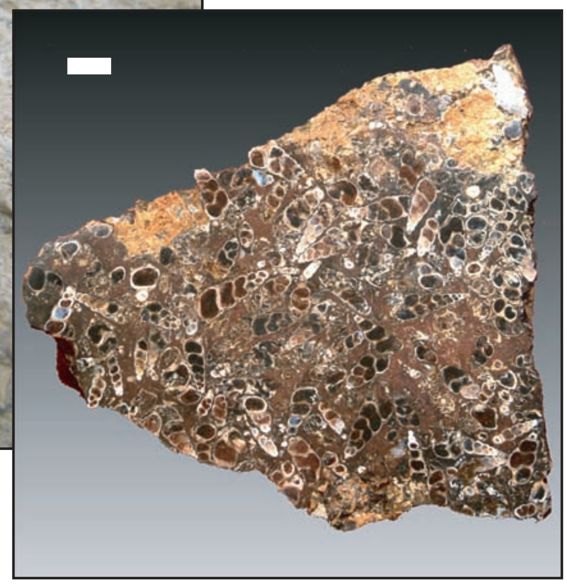

The Natural
(and Not-So-Natural)
History of
"Turritella Agate"

Like the Holy Roman Empire, the extinct Irish Elk, and Grape Nuts, "Turritella agate" is not what its name says it is: it is not agate, and it is not made of fossil snails of the marine genus *Turritella*. This has been realized by professionals and many amateurs for a long time, but the name (and the confusion it promotes) has persisted. For example, in 1947, *Hobbies* magazine misinformed its readers with the following statement: "Conditions must have been quite different in Wyoming in the days when the turritellas swarmed in a warm sea where high mountains now rise" (Lewis 1947). More recently, a website selling fossils similarly states the following: "Some 40–60 million years ago, an ancient saltwater sea covered what is now Wyoming. A snail of the *Turritella* species lived in its shallow waters" (www.madeonearth.com/gemstone/wind_chimes/wind_chimes.htm).

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The rock known as "Turritella agate" (fig. 1) comes from the Laney Member of the Green River Formation in southwestern Wyoming, northeastern Utah, and northwestern Colorado, from layers deposited in a series of ancient lakes that geologists call Lake Gosiute and Lake Uinta (fig. 2). The deposition took place in the early and middle parts of the Eocene Epoch, between around 51 and 49 million years ago (Ma). In other words, these rocks formed in fresh water. The real *Turritella* is a group of snails (probably containing more than a single genus) that lives only in the ocean. Genuine *Turritella* and its allies have a rich fossil record, with more than one thousand described species extending back to the Early Cretaceous Period, approximately 120 Ma. There are more than one hundred living species in the world's seas today. The shells in "Turritella agate" are distinguishable from real *Turritella* by being generally shorter and wider and by having axial as well as spiral sculpture on the shell (fig. 3).

The Name Game

Part of the confusion over the name of this beautiful rock comes from the fact that scientists them-

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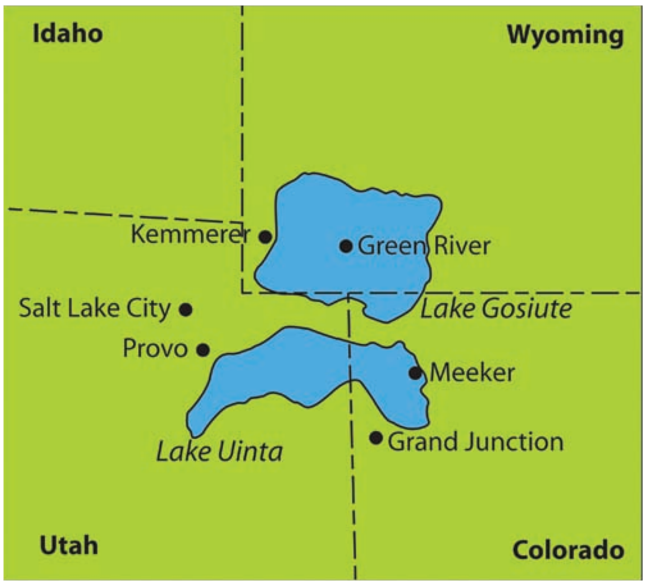
Figure 1 (left). **"Turritella agate" from Delaney Rim, near Wamsutter, Wyoming. The larger image shows the rock in its unpolished state, and the inset shows a polished piece revealing the characteristic brown-and-black color prized in the gem trade. Scale bars = 1 cm. Specimens in the collection of the Paleontological Research Institution.**

Figure 2 (below). **Generalized map showing the extent of ancient Lakes Gosiute and Uinta during the Eocene Epoch, approximately 50 million years ago. Modified from Grande (1984).**



selves cannot agree on the proper name of the snails. All agree that they are freshwater snails of the family Pleuroceridae. The fossils are most often assigned to the genus *Goniobasis*, which is still alive today. It contains at least one hundred described species that live in streams and rivers across much of the southern and midwestern United States. But some snail experts refer these species to the genus *Elimia*, often without adequate explanation.

The genus *Goniobasis* was first described by Isaac Lea in 1862, but most authorities think it refers to the same creatures as the genus *Elimia*, which was described by Henry and Arthur Adams in 1854. More rarely, the name *Oxytrema*, proposed in 1819 by Constantine Samuel Rafinesque, is used. Most biologists reject this name, even though it was described first, because Rafinesque did not provide enough information when he first described it. It is, therefore, referred to as a *nomen dubium*. Thus, by the rules of nomenclatural priority, *Elimia* wins.

But it's not that simple. Enormous confusion has arisen because the Adamses did not designate a particular species (known as a type species) to formally represent their new genus. The sixteen species they placed in it were extremely diverse, including what today would be recognized as three different genera. Consequently, the name *Elimia* was not adopted by most biologists in the nineteenth century.

The great Philadelphia malacologist Henry Pilsbry revived the name *Elimia* in 1896 but then mysteriously never used it again, preferring to use *Goniobasis* in his many subsequent papers. In a 1918 review of North American mollusks, Bryant Walker offered this explanation (page 149): "Dr. Pilsbry has more recently decided that *Goniobasis* should be restored to its former position as a generic term, on the grounds that *Elimia* was a composite group." Calvin Goodrich also used *Goniobasis* in an influential series of papers published between 1922 and 1944, and almost all authors followed him during the next fifty years.

Figure 3. **Individual specimens of *Elimia tenera* from the Green River Formation, showing considerable variation in shape and sculpture. Scale bar = 1 cm. Specimens in the collection of the Paleontological Research Institution.**

In his encyclopedic *North American Freshwater Snails* (1989), however, John Burch once again resurrected *Elimia*. In a short paper published in 2001, Burch gave the following explanation for his somewhat complex reasoning:

> Since *Elimia* H. & A. Adams 1854 has clear priority over *Goniobasis* Lea 1862, an appeal could have been made by me (or someone else) to the International Commission on Zoological Nomenclature in an attempt to conserve the name *Goniobasis*. But having knowledge of—and in fact participating in—the long battle to get the genus name *Pleurocera* conserved to fit its common usage convinced me that such an endeavor to save the use of the junior synonym *Goniobasis* would be futile, and in any event would take an inordinate amount of time, and certainly try the patience of malacologists.

Burch's decision to let both names stand has resulted in even more confusion. For example, the *Zoological Record* for

***Figure 4.* Panoramic photo of the Little America site, just north of Interstate 80, west of Rock Springs, Wyoming.**

the period 1980–89 reports twenty-nine uses of *Goniobasis* and nine uses of *Elimia*; and for the period 1990–2000, ten uses of *Goniobasis* and thirty-seven uses of *Elimia*. One widely used mollusk classification, published in 1989, uses *Goniobasis*; another, published in 1998, uses *Elimia*. The U.S. Endangered Species List also uses *Elimia*.

Collectors have tried to muddle through this nomenclatural morass, but one can hardly blame them for being confused or for throwing up their hands. Writing in *Lapidary Journal* in May 1963, June Culp Zeitner gave the following explanation:

> Current paleontological research has shown that the shells are not the marine genus turritella but rather a freshwater genus, probably *Goniobasis*. However the name Turritella agate is well established in the gem hobby and it seems unlikely that any more scientific name will soon replace its gem name.

A short article in the May-June 1997 issue of *MAPS Digest* (from the Mid-America Paleontology Society), which was reprinted in many fossil club newsletters, also tried (with only partial success) to straighten people out by writing:

> These fossils were not laid down in a sea, but in a freshwater lake. . . . Whoever named this agate only knew that the sea-snail Turritella had a high spiral shell. He jumped right in with this name without bothering to check the species out. The name has stuck, causing many people to be misled. These fossils are not even in the Turritella family; the true name is *Oxyterma genera* [*sic*]. A few years ago this species was known as *Goniobasis tenera* [*sic*] but further research caused the additional name change.

So what's the answer? Technically, *Elimia* has priority, but *Goniobasis* has wide usage. Often in such cases, as Burch acknowledged, the older but less-used name is "suppressed" and the later but more-used name "conserved"; however, that has not happened, and now *Elimia* also has wide usage in the biological literature. Freshwater mollusk expert Rob Dillon sees no choice but to keep them both. He writes*:

> The loss of either name at this point would be unconscionable. Thus it seems to me that both names ought to remain in currency, and that authors preferring *Goniobasis* should refer to "*Elimia*" in their text, while authors preferring *Elimia* also should refer to "*Goniobasis*."

At least for the famous Green River fossils, however, most serious publications in the past twenty years have used "*Goniobasis* agate," and this is probably the best we can do. Although not perfect, it is certainly better than continuing to call it "Turritella."

So much for the genus; what about the species? Unfortunately, this is not easy either. The *Elimia* snails of the Green River are probably all of one species, *E. tenera*, first described by New York paleontologist James Hall in 1846 (as *Cerithium tenerum*). Yet uncertainty remains. Like most members of its family, *Elimia* is devilishly variable (fig. 3), leading researchers to wonder whether its variants are genetic or due to the environment (the old nature/nurture debate). This problem was studied most recently by John Hanley in his 1974 doctoral dissertation at the University of Wyoming. Hanley reviewed all of the many forms of *E. tenera* and concluded that the environment was the dominant cause or, in techni-

*This nomenclatural history is taken, with permission, mostly from a very useful summary by Dr. Rob Dillon, available at www.cofc.edu/~dillonr/28Sept04.html.

Figure 5. **Close-up view of two "brown turritella" slabs from the Little America site. Specimens in the collection of the Paleontological Research Institution.**

cal terms, that the differences were "ecophenotypic." No one has studied these species in much detail in the past quarter-century. So, for the time being, the conservative choice is to refer to all of these high-spired snails in the "turritella agate" as *Goniobasis tenera.*

The Geology of *"Goniobasis Agate"*

Not only is "Turritella agate" not *Turritella*, it is not agate either. It is really chalcedony, i.e., a form of silica (SiO_2) made of submicroscopic, fiberlike quartz crystals. Agate is concentrically banded chalcedony, and "*Goniobasis* agate" is not banded. The form most sought-after for the gem trade is a dense, black to brown chalcedony in which the closely packed shells are blue to brown to white in color (fig. 1). This rock is found most abundantly in Sweetwater County, Wyoming, about 10 miles southwest of the scruffy, natural gas boom-town of Wamsutter, on a ridge called Delaney Rim. Here, it occurs as a capstone at the top of the ridge, although the layer—which ranges in thickness from about 5 to 30 cm (2 to 12 inches)—is not often visible in situ. Fragments large and small litter the ground, but collectors typically must dig 1–2 feet down to encounter the layer in place. This site has been written up in guidebooks and rock and mineral magazines for many years (see, e.g., the books by Graham [1996] and Hausel and Sutherland [2000] and the articles by Spendlove [1977] and Dolenc [1979, 1981]).

To make the dethroning of the traditional name complete, some of the fossil snail concentrations in the Green River are neither agate nor chalcedony. Farther west and south, the silicification is less dense, and the snail layers consist of a soft sandstone, sometimes described as "brown turritella" (figs. 4, 5).

There is much that we do not know about these impressive fossil deposits. First, we do not know their exact distribution in time or space. There are clearly multiple layers, but they have not been mapped in detail. Second, we do not know just how abundant these snails were in life. The enormous number of shells evident in the rocks (see sidebar) may represent the actual high abundance of living snails (modern *Elimia* are frequently found in high abundance—e.g., about nine hundred per square meter in a stream in Tennessee). It may be the result of the accumulation of many generations during hundreds or thousands of years; or it may be a bit of both. This is an important question to answer because of its implications for the biological productivity of the Green River lake ecosystem and the potential role of this productivity in the snails' evolution. Based on what modern ecologists have learned about these snails, the food supply appears to play a role in controlling their abundance. This is an important area for future research.

Finally, we do not understand the details of the composition of the rock itself or how it formed. The petrological work that has been done reveals some intriguing facts, such as: some samples are weakly fluorescent, and others contain measurable amounts of gold. Although the processes by which chalcedony forms are not well understood, it is likely that the silicification of this rock owes its origin to eruptions of ash from volcanoes (probably to the west); silica in the ash was dissolved and transported through the underlying sediments where it precipitated out as chalcedony. Future research might alter this scenario.

Human Use and Misuse

Goniobasis agate is very popular as a gemstone for both jewelry and other decorative pieces (fig. 6). The packing of the shells and the spectrum of colors may be responsible for this popularity. Even more interesting is the apparently widespread use of this stone for mystical, metaphysical, or "new-age" purposes. A Google search for such properties produces a surprisingly long and diverse list of results. To a skeptical geologist, however, such a list produces one overwhelming question: Why exactly do people think this particular rock can do all these things—from subduing superiority complexes to settling stomachs?

The attribution of mystical properties to agates is certainly not limited to the new age. Ancient Greeks and medieval Europeans valued agates for their attractive colors and patterns and frequently assigned metaphysical or medical attributes to them. Native Americans are known to have used many kinds of rocks and fossils for decorative and ceremonial purposes. I have not, however, been able to find any authoritative information about whether Native Americans knew about or used agates for such purposes prior to European contact. One recent book, *American Indian Secrets of Crystal Healing* by Luc Bourgault (1997), suggests intriguingly that in Native American tradition agates have metaphysical properties associated with their frequently banded or variegated appearance:

> The agates come in a variety of colours and display different lines or layers, symbolizing the integration of different facets of the body. When you go into deep meditation you will become aware of the body's complexity, because that is precisely what meditation aims to integrate, the different facets of the body, in order to arrive at a united, balanced whole. The agate is very beneficial for this process, which is why it is also a good protecting stone when travelling. Having to uproot oneself can create a feeling of instability and of being lost. This stone will help you become more settled, wherever you happen to be.

Whether these ideas originated in pre-contact Native American traditions is unclear. The only suggestion I have been able to find of an indigenous Native American mystical use for *Goniobasis* agate comes from a website called "Gray Wolf Spirit Stones": www.graywolfspiritstones.com. According to the site, the stone brings good luck, and the reasoning for this attribution is similar to that described by Bourgault for agates. That is, the rock contains shells that might plausibly be identified as "sea shells" (even though, as discussed above, they are not). Since the rock is today found far from the ocean, this implies a great distance traveled, either by stones or water. Great travels are difficult and dangerous; thus, to "find spirit of shell without having to travel many moons was great good fortune." The origins of this information, however, are also mysterious. When I queried the owner of the site for the source of this information, I was told only that it came from other websites. This site was accessed in 2004; by May 2006 it was no longer active.

Nevertheless, one might speculate that there is a genuine Native American tradition that attributed mystical properties to a particular stone by some reference to a clearly visible physical property of that stone, and that such a property of the stone reminds someone of something (e.g., "banding suggests integration"; "seashells far from the ocean without risky travel implies good fortune"), which becomes the basis for attributing a metaphysical property to the stone. In her recent book *Fossil Legends of the First Americans*, Adrienne Mayor (2005) discusses this pattern of thought, in which the shape and appearance and color of stones and fossils suggest their metaphysical properties, or "medicine." The missile shape of fossil belemnites, for example, led them to be labeled as "thunder stones" or "weapons of the gods." The Zuni collected these fossils as war amulets and passed them down for generations. In South Dakota, the Sioux believed that they were the lightning-bolt "ammunition" that the Thunder Birds hurled against the Water Monsters. Among the Blackfeet and other groups, baculite ammonite fossils were called "buffalo calling stones," and they were collected as amulets with the power to summon buffalo. The reason for this notion was that the fossils fracture along the complex sutures of the shell, frequently yielding shapes that resemble a miniature bison.

Fanciful though these beliefs are to the modern scientific mind, they do at least have some basis in the material properties of the stones themselves. They are thus quite different from the majority of modern new-age properties ascribed to many stones and crystals today.

Conclusions

About 20 per cent of the results of a Google search on the word "turritella" are *Goniobasis* agate, and about a quarter of these—more than 700 websites—have to do with

How Many Shells Are There In "Turritella Agate"?

There are clearly numerous stratigraphically separate beds of *Goniobasis* agate within the Green River Formation. The bed from which the famous black agate is mined at the classic site near Wamsutter is probably a maximum of about 40 cm (1–2 feet) in thickness, with lesser but probably not much greater thicknesses elsewhere. If we assume what seems the minimum probable lateral extent of this bed (the area of the Delaney Rim, approximately 50 square kilometers [20 square miles]), and suppose that there is uniform density of perhaps one shell per cubic centimeter (approximately sixteen shells/cubic inch), then there may be about 1 trillion individual fossil shells preserved in this bed alone.

Figure 6. **A pair of bookends and a skull-shaped paperweight, just a couple of the many decorative uses of "turritella agate." Objects in the collection of the Paleontological Research Institution.**

the supposed mystical properties of this rock. Compared to the web as a whole, this is not much, and, in any case, Google (for the moment at least) does not provide all the answers. Furthermore, one cannot spend one's life refuting all the misinformation one runs across. But this instance is especially bothersome to paleontologists who study fossil snails. There is a huge amount we do not yet know about *Goniobasis* agate. Yet instead of being a stimulant for critical thinking and scientific inquiry, this very popular stone is evidently too often a stimulant of pseudothought. Instead of an opportunity to think intelligently and learn about the natural world, it provides an opportunity to simply make things up and pass them off as "reality." Our modern lives are already filled with enough such opportunities for virtual reality and enough promulgators of hokum. Fossils, of course, can and should be enjoyed aesthetically, but they should also be windows into a past that really existed and stimulants to pursue further one of humanity's greatest accomplishments—discovering that our Earth and its life have a long and complex history.

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Note: A more complete bibliography is available at: www.priweb.org/Research/Turitella%20Agate.htm. ❑