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Brigitte Buettner

ICY GEOMETRY: ROCK CRYSTAL IN LAPIDARY KNOWLEDGE

Before the development of the modern sciences of zoology, botany, and mineralogy, surveying the objects that make up the three natural kingdoms was an epistemological task associated with distinct literary genres: the bestiary, the herbal, and the lapidary. Although less studied than their textual cousins, lapidaries were as much in demand throughout the Middle Ages and into the early modern period. They survive in hundreds of manuscripts, whether as stand-alone texts, as parts of compilations, or as chapters in all-encompassing encyclopedias.[1] Book 37 of Pliny's *Natural History* (analyzed by Patrick Crowley in this volume) served as their foundation stone. The first-century encyclopedist gathered a wealth of earlier sources to compose his imperially scaled work. Of the forty-odd works he relied on for the book on precious stones, only the *De lapidibus* written by Aristotle's student Theophrastus (d. ca. 287 BCE) has come down to us. Ideas about the formation and behavior of geological objects reached much further back, however, as they were rooted in an ancient transcultural bedrock that stretched from Vedic India to the ancient Near East and Pharaonic Egypt. Both the shared textual ancestry and the cognitive habit of favoring authoritative sources (*auctoritates*) over firsthand observation explain why premodern books on stones sound alike across linguistic barriers and cultural divides; why Christian, Jewish, Byzantine, and Islamic lapidaries assess rock crystal in very similar terms.[2]

Far from being a marginal intellectual endeavor, lapidaries enjoyed considerable prestige throughout the medieval period, both East and West. They were composed by outstanding scholars and eminent churchmen, such as the Persian al-Bīrūnī (d. 1048), one of the greatest medieval *savants* (see the essay by Avinoam Shalem), and the German Dominican Albert the Great (Albertus Magnus, d. 1280), as insightful a theologian as he was an inspired commentator on Aristotle's writings dealing with the physical world. Owing to the instability of literary artifacts before the invention of printing, lapidaries come to us in versions authentic and corrupt, bare-bones and glossed, prose and verse, Latin and vernacular. Some survive in scores of manuscripts while others did not make it past a single copy. Further proof of the popularity of a genre that may strike us today as repetitive and unimaginative is the fact that lapidaries attracted a broad and diverse readership: we know of owners who were monks, nuns, friars, clerics, teachers, doctors, lawyers, merchants, and nobles. And we also know a few who had their volumes embellished with illustrations, the focus of the present essay.

In short, contrary to modern appraisals, which until recently have tended to dismiss premodern efforts in the area of natural history as naïve and bookish, lapidary knowledge (to use a less anachronistic term than mineralogy) was regarded as a pursuit of the highest order. Likewise countering prevalent views according to which medieval cultural productions were invariably geared toward spiritual aims, the mainstream lapidary tradition is distinctly matter-of-fact, its premises and concerns more closely aligned with the medically oriented herbal than with the thoroughly allegorized bestiary. Pliny's *Natural History* shaped that descriptive direction, as did another influential text published around the same time: Dioscorides' *De materia medica* (On the Materials of Medicine). The massive compilation, backbone of Western, Byzantine, and Islamic pharmabotanical knowledge, itemizes almost 5,000 individual medical uses. Most preparations

I wish to thank Cynthia Hahn and Avinoam Shalem for having invited me to participate in this project.

1 The best overview of medieval lapidaries remains Joan Evans, *Magical Jewels of the Middle Ages and the Renaissance, particularly in England* (Oxford: Clarendon Press, 1922; repr. New York: Dover Publications, 1976).

2 Islamic lapidaries consider specific weight and price, both absent in Western counterparts.

derive from plants, but among the non-botanical ingredients some twenty-five are of mineral origin, although rock crystal is not one them. All this is not to suggest that there was not a lively tradition of allegorized lapidaries, for which the encyclopedia written by Hrabanus Maurus will provide an example toward the end of my discussion.[3] Still, the churchmen who authored the most important lapidaries—from Isidore of Seville in the early sixth century to the Dominicans and Franciscans of the scholastic age—felt no particular urge to gloss lithic objects. Rather than asking precious stones, including the ten or so members of the crystalline group, to be messengers of didactic lessons, they regarded them to be self-sufficient witnesses of God's bountiful and beauteous creation.

Rock Crystal: Hardened Ice?

The reliance on *auctoritates* explains why neither the descriptive protocol nor the content of lapidaries vary much over the centuries. Typically, an entry starts by providing information about a stone's name, etymology, color, and essential physical attributes; its known places of origin are listed next, followed by its active properties. Called *virtutes*, these performative powers could be optical (as with the super-luminous carbuncle that glows in the dark) or physical (as with magnets). But they were first and foremost of a medical and magical character insofar as the firm anthropocentric outlook of medieval natural philosophy dictated that even stones be serviceable to humans. The range of action was enviably broad: stones were equipped with the ability to make invincible and invisible, to shield from storms and snakes, to cure all manners of corporeal diseases and mental illnesses, to prevent nightmares and demonic attacks, and much, much more. So important was the concept of *virtutes* that lapidaries took it as an ontological benchmark: stones endowed with powers were precious, no matter how striking or dull they looked; those devoid of action were mere clumps of earth. To borrow a term coined by postmodern theorist Jane Bennett, vibrant matter constituted the texture of precious stones; and that brought them functionally close to miracle-producing relics and healing plants.[4]

What, then, characterizes rock crystal? Lapidaries unvaryingly note that its name enfolds its very essence, since *crystallus* traces back to the Greek word for both ice and crystal. More than a lexical affinity, however, theirs was a generative bond, given that the latter was quite literally born from the former. For the most irrefutable corroboration, medieval writers need look no further than the Bible. Ecclesiasticus 43:22 states that the divine work extends to water "congealed into crystal" (*et gelavit crystallus ab aqua*), adding that this eco-transmutation takes place where "the cold north wind bloweth." Then there was Pliny's equally lapidary statement: "it is certain that crystal is a kind of ice."[5] But if no one contested that water can morph into ice, accounting for the next step proved more of a challenge: How could ice solidify into stone, that is, slip from one element (water) into another (earth)? Was it parallel to the process witnessed in the formation of stalactites and stalagmites, only much longer and conditioned by extreme environmental circumstances? Quite a few writers hesitated, uncertain if they should take the *Natural History* (not to mention the Bible) at face value, or pay heed to Isidore of Seville's *Etymologies*. For while the most widely disseminated medieval encyclopedia copied the relevant passage (as much else) from Pliny, its author simultaneously introduced a note of dissonance by interpolating a distancing "it is said [*traditur*]"[6] Isidore's deconstructive move is particularly revealing when one remembers that he was committed to a kind of verbal essentialism for which the non-arbitrary relationship between the name and the thing, so powerfully epitomized by the *crystallus*, stood as evidence of a well-tempered universe, one that brooks no gap between *res* and *signa*.

Other authors more decidedly rejected the notion that a stone was nothing but compacted and permanently hardened ice. Credit for the initial critique goes to Solinus. He reasoned that if rock crystal were, at bottom, nothing but ice, it could not be found on Cyprus and in other warm places.[7] So elusive is Gaius Julius Solinus that specialists date his only known work, the *Collectanea rerum memorabilium* (Collection of Memorable Things), anywhere between the third and the middle of the fourth century, the late third century being the most likely. Modern scholarship has not been kind to Solinus. More often than not, he has been denounced as a flat-footed plagiarist of Pliny, and his information rejected as unreliable, trivial, and sensationalist. Judging from the number of surviving copies, medieval audiences greatly enjoyed his monsters-

3 Comprehensively examined by Christel Meier, *Gemma spiritalis: Methode und Gebrauch der Edelsteinallegorese vom frühen Christentum bis ins 18. Jahrhundert* (Munich: Wilhelm Fink, 1977).

4 Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham, NC: Duke University Press, 2010). Lithic agency is also central to Jeffrey Jerome Cohen, *Stone: An Ecology of the Inhuman* (Minneapolis: University of Minnesota Press, 2015).

5 Pliny, *Natural History*, 37.23, trans. D. E. Eichholz, Loeb Classical Library 419 (Cambridge, MA: Harvard University Press, 1962), 181.

6 Isidore of Seville, *The Etymologies*, 16.13.1, trans. Stephen A. Barney et al. (Cambridge: Cambridge University Press, 2006), 325.

Fig. 1 Rock crystal vessels in Scythia, Solinus, *Collectanea rerum memorabilium*, Italy, 1300–1350. Milan, Veneranda Biblioteca Ambrosiana, MS C inf. 246, fol. 24r

and-marvels universe. User-friendly, the *Collectanea* repackaged the sprawling *Natural History* into a portable edition by mapping the content onto a spatial grid that guided readers through an invigorating mental journey from Rome to the edges of the world. Along the way, they could sample noteworthy topographic features, exotic flora and fauna, peculiar creatures and unorthodox mores, and, as they traveled further East, an abundant array of mineral riches.

Only a few of the roughly 250 manuscripts that preserve the *Collectanea*, in whole and in fragments, are illustrated. The most lavish, now housed in the Biblioteca Ambrosiana in Milan, is dated to the first half of the fourteenth century, though it is assumed that the stately codex reproduced a sixth-century Byzantine template, itself likely a copy of a late antique prototype. Its unique pictorial cycle authenticates many facts and factoids Solinus enlisted to capture the attention of his readers. However, one searches in vain for stony *mirabilia*—that is, with the exception of rock crystal (see fig. 1). The best variety of the transparent stone is found in Scythia. Close enough to the Greco-Roman world to be known and yet sufficiently removed to allow fantasy to do its work, the vast region in Central Asia north of the Black Sea was indexed in ancient and medieval ethnogeographic lore as a barren and inhospitable territory, and a favorite habitat for fierce animals and bloodthirsty cannibals. Compensating for such unrewarding environs, its soil was believed to be filled with gold and blessed with precious stones. In addition to the sky-blue *cyanus* (a stone noted for its explicit gendered nature since it comes in both male and female specimens), Scythia yields high-grade emeralds. By reproducing a long-standing mythopoetic tradition, Solinus assured his readers that terrifying griffins guard the coveted green rocks. And that those animals, part eagle, part lion, are locked in an endless battle with another non-normative species: the savage, one-eyed Arimaspians, who attempt to lay their hands on the priceless commodities.

Suggesting that it is the dialectics of dread and desire that generates value, the colored sketch foregrounds the antagonistic relationship between the two hybrids. Curiously, no emerald is visible, even though its name appears in the prominent caption. That omission makes the visual endorsement of rock crystal all the more remarkable. Unusual too is the choice of a figurative language, one that introduces the stone as an artifact, or rather two: a pair of stout drinking vessels placed on slender tripods and stored underneath a blue table that effectively doubles as a frame. To redirect our attention toward the material, the inscription labels the objects as *cristallina vasa*, where the text merely speaks of *pocula* or drinking cups.[8] Picturing transparency—that is, near-nothingness—is a complicated representational exercise. In this case, the perceptive artist responded to the challenge by applying delicate lines against the bare parchment: cream-colored for the external contours; black, blue, and red for the handles, rims, and internal divisions. He then completed the mimetic labor by adding dark dots to echo the carvings that often adorn Roman and late antique crystal objects. Besides simple lines and circles, these could turn into full-fledged

7 Pliny entertained those objections too but explained them away as either alluvial deposits or hardened sky-borne moisture.

8 Solinus, *Collectanea*, 15.29–31, in Kai Brodersen, ed. and trans., *Solinus: Wunder der Welt. Collectanea rerum mirabilium* (Darmstadt: Wissenschaftliche Buchgesellschaft, 2014), 148–49.

iconic signs, as is the case on the fragment of a bowl, now at the Metropolitan Museum of Art in New York (see Plate 13b). Etched with raised fish and shells, the surface self-reflectively betokens the watery element in both its décor and material.

While the cup is small, the fictional receptacles in the Ambrosiana manuscript appear considerably larger. Their size may refer to the piece of crystal weighing a full 150 pounds that Livia, the wife of Emperor Augustus, donated to the treasury of the Capitoline Temple. Pliny, Solinus, and their medieval successors report that anecdote, usually in conjunction with the observation that flawless crystal specimens are rare. Fluid inclusions, gas bubbles, and salt specks indeed tend to mar minerals of the quartz family.[9] A rusty tint (caused by iron oxide stains) and uneven surface (the result of conchoidal fractures) add to these blemishes, which is why utterly transparent pieces of rock crystal would have struck medieval observers as an intrinsic marvel.

Motifs carved onto crystalline surfaces were cause for added appreciation. Measuring seven on the Mohs scale, rock crystal is a relatively tough stone. Chisels and drills, their tips outfitted with abrasives obtained from diamond splinters and crushed corundum (such as emery), had been used for a long time to score its rocky skin and bore through its body. The twelfth-century German Benedictine monk who wrote under the adopted name of Theophilus treats the subject of crystal polishing and carving in his well-known manual on the arts.[10] Splicing firsthand knowledge into textually transmitted references, he is primarily concerned with technical procedures. After endorsing a two-step variant of the standard ice-formation theory ("Crystal is water hardened into ice, and the ice of many years hardened into stone."), he proceeds to detail how a piece is best worked. Except that his generally sober guidelines here take a strange turn: in order to soften the rock, he advises fellow practitioners to insert it into the chest of a young goat whose legs have been bound and whose body has been slit open "in the position of the heart." Cruelty against animals seems of no concern to the monastic artisan, who goes on to recommend that the intervention should be repeated as often as it takes to keep the crystal warm. Theophilus was not the inventor of this queer practice, if practice it ever was. His intervention was intertextual, not physical: he simply transposed a treatment that lapidaries reserve for the diamond. Known by its Greek name *adamas*, meaning "indomitable" or "invincible," ancient and medieval gem cutters had a well-developed working knowledge of how to handle the hardest naturally occurring substance by using diamond against diamond. Even so, our texts maintain that hammers are ineffectual, and then proceed to mythologize a method for softening hard stones through the application of heat by asserting that only the warm blood of a male goat has the power to overcome such an unyielding material.[11]

Thirteenth-century encyclopedias always incorporate a lapidary section as a complement to the chapters that document plants and animals. Their erudite authors had no problem in repeating the diamond-and-goat story but followed Isidore of Seville in showing more restraint when it came to rock crystal's alleged gestation from ice. The most considered objection is found in Albert the Great's mid-thirteenth-century *De mineralibus*. A landmark publication in the Western history of earth sciences, *The Book of Minerals* combines a routine lapidary with an exploration of carved gems. More innovatively—and more speculatively—it examines the formation of telluric objects as well as the propagation of *virtutes* from celestial to terrestrial bodies. Largely inspired by Islamic expansions and refinements of Aristotelian theories, Albert's geological framework identified earth and water as the necessary building blocks of every mineral and metal. A liquid, even when subjected to intense pressure or extreme cold, cannot coagulate into a durable wholeness unless it merges with some solid matter; conversely, dry materials are bound to crumble without the help of a little agglutinative moisture. As such, no stone, even the most pellucid, like quartz of optimal quality, can be formed without the presence of some "very subtle earth." Albert concludes that the development of crystal is best understood by analogy to the alchemical process that produces glass from sand, save for the fact that the manufacturer is Nature herself and the result assembled "without difficulty or toil."[12] From that argument, it would take but one small step to the now

9 Patrick R. Crowley, "Crystalline Aesthetics and the Classical Concept of the Medium," *West 86th: A Journal of Decorative Arts, Design History, and Material Culture* 23, no. 2 (2016): 239–41, refers to the fifth-century epigrammatist Claudian who took the inclusions as proof of crystal's watery origins. One finds the same observation in Muḥammad ibn Aḥmad al-Bīrūnī, *The Book Most Comprehensive in Knowledge on Precious Stones: Al-Beruni's Book on Mineralogy*, trans. Hakim Mohammad Said (Islamabad: Pakistan Hijra Council, 1989), 163–64.

10 Theophilus, *The Various Arts: De Diversis Artibus*, 3.95, trans. C. R. Dodwell (Oxford: Clarendon Press, 1986), 168–71. The most comprehensive study of medieval rock crystal work is Hans R. Hahnloser and Susanne Brugger-Koch, *Corpus der Hartsteinschliffe des 12.–15. Jahrhunderts* (Berlin: Deutscher Verlag für Kunstwissenschaft, 1985). And for a succinct overview, *Grove Art Online*, s.v. "Rock crystal," by Genevra Kornbluth, www.oxfordartonline.com.

11 Pliny, *Natural History*, 37.59–61, 210–11.

12 Albert the Great [Albertus Magnus], *Book of Minerals*, 1.1.3, trans. Dorothy Wyckoff (Oxford: Clarendon Press, 1967), 16–17.

Fig. 2 Beryl Sphere as a Burning Glass, Jacob van Maerlant, *Der naturen bloeme*, Flanders, ca. 1287. Detmold, Lippische Landesbibliothek, MS 70, fol. 132r

commonsensical remark that if a rock were nothing but solidified fluid, it would melt away during hot summers and be absent in warm places—essentially, Solinus's intuition for discarding the frozen-ice paradigm.

Of Fire and Milk: Crystal Virtues

The most successful medieval lapidary, the late eleventh-century *Liber lapidum*, remains noncommittal on this issue. Its author, Marbode of Rennes (d. 1123), subscribes to the "opinions of some experts" who support the idea of an icy provenance only to bring up those who oppose it. The bishop's mineral passions lay elsewhere, as he was the first to significantly expand stones' performative repertoire. By this measure, the *crystallus* is meagerly endowed. Marbode retained from his sources two *virtutes* only, one physical, the other medical: rock crystal acts as a burning lens when in the shape of a sphere whereas it stimulates milk production in lactating women when powdered and mixed with honey.[13]

As the leading *auctoritas* in matters of lapidary knowledge, the *Liber lapidum* enshrined those properties for subsequent generations of readers. In at least one case, the reader was an artist who gave visual confirmation to the use of crystal balls as burning glasses (see fig. 2). We are in a copy of *Der naturen bloeme* (The Flower [or Best] of Nature), the Middle Dutch rendition of Thomas of Cantimpré's *Liber de natura rerum* (The Book on the Nature of Things), dated circa 1240. Jacob van Maerlant completed the free translation of the widely read Latin original some three decades later, and the manuscript presently in the Westphalian town of Detmold was created not long after. Its ambitious pictorial cycle of 500 miniatures may not be of the greatest artistic merit, but it stands as a compelling example of the emergent interest in visualizing scientific knowledge. Furthermore, the unknown patron who commissioned the engaging volume and the artist who executed his wishes made an atypical choice in opting for pictures that stress human interactions with each of the twenty-two stones (the mineral chapter ends abruptly with hematite). As the original users paged through the book, witnessing one *virtus* after another, they must have come away with a good understanding of lithic agency and its anthropocentric orientation. Because of a mix-up in the layout, the burning glass appears next to the *borax* (a stone wrested from the head of a toad) when it should have headed the entry for the *beryllus*. That stone's lovely blue-greenish complexion drew comparisons to seawater, from whence we derive the name of aquamarine. In medieval texts, the likeness led to a semantic slippage: the stone became "clear as water," justifying its assimilation to the class of transparent minerals. However abbreviated the image may look to us, it skillfully confirms the perplexing

13 Marbode of Rennes, *Liber lapidum*, 41, ed. with Spanish trans. María Esthera Herrera (Paris: Les Belles Lettres, 2005), 136–37. The only English version currently available is a flowery Victorian translation reproduced in the edition by John M. Riddle, *Marbode of Rennes' (1035–1123) De Lapidibus, Considered as a Medical Treatise with Text, Commentary and C. W. King's Translation, Together with Text and Translation of Marbode's Minor Works on Stones* (Wiesbaden: Steiner, 1977), 77–78.

fact that a glass-like object is able to catch the rays of the sun, then bundle them into beams of fire powerful enough to destroy debris placed on the opposite side or, as in this case, in a person's hands. That a see-through body, moreover one that feels cool to the touch, can set things alight would not fail to register as a material enigma on a par with the hardening of water into ice and the ensuing petrification of ice into rock. It is this dynamic combination of antithetical qualities, this seamless union of solid and transparent, hard and liquid, cold and hot, that secured stones affiliated with the crystal group a spot in the vast theater of preternatural marvels.[14]

Oddly, lapidaries did not seize the opportunity to refer readers to a practical use of glossy crystal and beryl balls. Dating back to antiquity, such spheres are a regular presence in princely inventories of the later Middle Ages. Called *pommes de cristal* in French documents, they were much appreciated (by those who could afford them) for providing a sensation of relief during heat waves and in cases of high fever. A handful of "crystal apples" have survived. The one owned by the Kunstgewerbemuseum in Berlin still comes with its purpose-made, finely tooled leather case (see Plate 12a). Also preserved is the silver mount; provided with a large loop, it allowed the polished orb to be attached to a girdle, rather like the talismanic examples found in early medieval graves discussed by Genevra Kornbluth in this volume. While lapidaries omit explicit mention of cooling balls, they preserve the functional connection between rock crystal and coldness by underscoring that the cups crafted from that material can only hold chilled drinks. That insight would point to an experiential awareness of quartz as an excellent thermal conductor, but it is historically more accurate to view it as an expression of associative reasoning. Similitudes, so the thinking went, brought disparate orders of beings into conceptual proximity and in the process revealed something about the material identity of individual things.

The underlying conceptual scaffolding of such analogizing was provided by sympathetic action. Medieval natural history perpetuated the ancient assumption that universal forces—the pull of sympathy and the push of antipathy—regulate the interactions between all sublunary entities. Sympathetic action explains why yellow-hued stones cure jaundice and purple amethyst improves the quality of wine (or takes care of hangovers); why crystal vessels are appropriate for cold drinks and why the same stone can pass its cooling benefits onto the human body, for example, to

Fig. 3 Rock Crystal as a Thirst-Quencher, *Hortus sanitatis*, Jacob Meydenbach, Mainz, 1491. Cambridge University Library, Inc. 3.A.1.8[37], fol. 377v

moderate hot passions, such as anger and lust. Minerals generally feel fresh to the touch, but it was sympathetic energy that predestined crystal to work by itself as a thirst quencher. An illustration of the *Hortus sanitatis* responded to that prompt (see fig. 3, left). Published in 1491, the "Garden of Health" is a substantial compendium that strings together an herbal, a bestiary, and a lapidary. Belonging to the first generation of scientific publications in print, the text amounts to not much else than a cut-and-paste job of quotations pirated from familiar sources, including Pliny, Albert the Great, and Solinus (for the critique of the hardened-ice theory). As further evidence of the continuity between medieval and early modern understandings of matters geological, the illustrations of the *Hortus* likewise recycled existing compositions. The only real novelty consists in the dramatic increase of the number of pictures, for Jacob Meydenbach, the Mainz printer who issued the book, wagered that the best way to ensure its commercial

14 On the importance of the rhetoric of wonder in medieval and early modern natural scientific discourses, see the seminal work by Lorraine Daston and Katharine Park, *Wonders and the Order of Nature, 1150–1750* (New York: Zone Books, 1998); and for medieval culture more specifically, see Caroline Walker Bynum, "Wonder," *American Historical Review* 102, no. 1 (February 1997): 1–26.

success was to have it heavily illustrated. While it appears that this was such a major miscalculation that it put him out of business, it did give us a book that inventively pairs the verbal portraits of every plant, animal, and stone with an image, some quite realistic, others more schematic.

To keep costs down and expedite production, printers were in the habit of reusing existing woodblocks; when that was not an option, they charged draftsmen with the task of reproducing engravings and miniatures found in other books (the concept of plagiarism did not yet exist). Meydenbach must have found the model for the stone-sucking scene in a volume of *Der naturen bloeme*. The Detmold manuscript is a good candidate, for it, too, sports the thirst-slaking scene (see fig. 4). Due to the layout mistake mentioned earlier, it appears next to the entry on the *absinctus* (a heavy, heat-retaining stone) when it should have accompanied the description of *alectorius*. Lapidaries claim that this bean-sized mineral is a crystal look-alike, even if gestated in the messy entrails of an old rooster rather than forged from pure ice. Complementing its hydrating benefits, it promises to steel knights to their core, making their soft flesh and vulnerable organs immune to blows on the battlefield. Another dose of sympathetic ardor steers the aptly named "Cock stone" toward sexual performance, though its inbuilt masculinity is such that lapidary authors fantasized not only about increased potency but also about its service in forcing wives into acquiescing to their husbands' every desire.

The second, more properly curative virtue that Marbode and other lapidaries ascribed to rock crystal operated according to the same assumed correlation between human body and mineral body. For when crushed and dissolved in a honey-flavored infusion, its erstwhile watery state predisposes it to act as a liquefying agent, facilitating the flow of milk. To the best of my knowledge there are no pictorial renderings of this use, but the eye-catching crystal cabochons that occasionally disrupt the wombs of the Virgin and other sainted women in late medieval devotional statuettes may well be, as Jacqueline Jung has argued, a three-dimensional transcription of the same idea. Unbreakable and yet miraculously diaphanous, assertively corporeal and yet transfigured into ethereal near-nothingness, these stony grafts gesture toward spiritual nourishment as a sweet and never-depleted reward for the deserving soul.[15]

Fig. 4 *Alectorius* as a Thirst-Quencher, Jacob van Maerlant, *Der naturen bloeme*, Flanders, ca. 1287. Detmold, Lippische Landesbibliothek, MS 70, fol. 131v

Large plano-convex crystal cabochons were more generally deployed on reliquaries to frame, enlarge, and exalt inconspicuous fragments of bones, splinters of wood, and other vestiges of martyrial suffering. One of the earliest attestations of this use exemplifies how medieval writers could be attentive interpreters of materiality. Written in the 1120s or 1130s, William of Malmesbury's *Gesta Regum Anglorum* (Deeds of the English Kings) draws on an earlier source to tell the story of the presents that the Frankish ruler Hugh the Great (d. 956) dispatched across the Channel to woo Eadhild, half-sister of Æthelstan, king of the West Saxons. Among the "gifts of truly munificent scale," the royal recipients could admire a particle of the True Cross "enclosed in crystal, which the eye can penetrate, solid rock though it is, and discern the wood, its color and its size."[16] The formulation perfectly sums up crystal's magic at its most basic—for how can a rock that allows sight to bore through it not be wondrous?

Lapidaries seem strangely indifferent to this optical *virtus*. One exception is Bartholomaeus Anglicus's *De rerum proprietatibus* (On the Properties of Things). The English friar had planned his encyclopedia, finished about 1240, as a handy reference tool for the rank-and-file members of the Franciscan order. Translated into various vernacular languages, it quickly reached a more varied audience, and also was more frequently illustrated than related

15 Jacqueline E. Jung, "Crystalline Wombs and Pregnant Hearts: The Exuberant Bodies of the Katharinenthal Visitation Group," in *History in the Comic Mode: Medieval Communities and the Matter of Person*, ed. Rachel Fulton and Bruce W. Holsinger (New York: Columbia University Press, 2007), 223–27.

16 William of Malmesbury, *Gesta Regum Anglorum: The History of the English Kings*, 2.135, ed. and trans. R. A. B. Mynors, completed by R. M. Thomson and M. Winterbottom (Oxford: Oxford University Press, 1998–99), 1:218–21.

encyclopedic enterprises. Quoting Isidore of Seville, Bartholomaeus starts by rehearsing crystal's conventional properties and virtues, then spells out its magnifying powers; or, as he puts it, its ability to "manifest" letters and other things placed "in it."[17] *Lapides ad legendum*, as such vision aids were known, assisted farsighted readers before the invention of eyeglasses in the fourteenth century.[18] Scryers, of course, had recourse to crystal balls for that same reason, except that the objective of their immersion into the stone's frozen depths was not physical magnification but the predictive decoding of future events, a practice the Church harshly condemned as pure wizardry.[19] And while Bartholomaeus Anglicus and many other ecclesiastical men who authored lapidaries could be generously receptive to stones' magical properties, they chose to keep mum about this subversive use of the perception-altering instrument.

Purged of occult connotations, a revelatory crystal lies at the heart of a complex mise-en-scène between self and other at the beginning of the *Roman de la Rose*.[20] The first part of the famous allegorical dream poem written by Guillaume de Lorris around 1230 opens with the vision of a walled pleasure garden. We follow the Lover as he steps into the lush surroundings and reaches a beautiful fountain (or spring)—the same, he learns, that had trapped Narcissus in his mirror-image and self-love. Pierced by the arrows shot by the God of Love, the Lover is now primed to begin the amorous quest for his own special rosebud. A mid-fourteenth-century illustration nicely conveys a sense of narrative anticipation, making us worry for the pensive-looking youth who sinks his gaze into the deceiving pool (see Plate 12b). At the same time, it provides proleptic clues to intimate that, unlike the ancient hunter, the courtly Lover will turn toward the outside, toward the bush behind the wattle fence, ready to pluck the rose of his desire. In order to connect beginning to end, the illuminator used the same minium red for the flowers and the flame-emitting rock. Emerging from the water, rubbing against the rim of the fountain, the bulky mass at first comes across as an incongruous intruder. The result of the image's betrayal of the text, which clearly speaks of two transparent stones, this single rock nevertheless is unique in validating the crystal in its eye-opening and mind-expanding role.

Like many of his peers, Guillaume de Lorris was fluent in lapidary knowledge. Thus, when he specifies that these stones emit "more than a hundred colors" after beams of sunlight reach them at the bottom of the fountain where they are planted in a silvery gravel, it is on the strength of a property lapidaries reserve for the *iris*; in essence, a pure, well-formed quartz. Splitting white light into the spectrum was perceived as another physical exploit because it seemed that the "Rainbow stone" managed to extract color from an achromatic body. While that perceptual prowess automatically enrolled it in the archive of natural wonders, it also stimulated experimental habits in a long line of natural philosophers. From Arabic scientists to Roger Bacon and Isaac Newton, theorists of optical laws used iris prisms and other hexagonal quartzes to scrutinize the behavior of light, investigate the nature of color, and pierce the mystery of vision. Further narrowing the gap between mineral and sight, medieval physiological models posited that a crystalline humor lodged inside the eye acts as a conduit for conveying images between the outside world and the brain. Like the stone itself, this soft internal lens was assumed to be of an ice-like limpidity so as to let the flow of sensory impressions pass unimpeded all the while precisely focusing the gaze.[21] In the *Roman de la Rose*, the crystals facilitate the play of refractions and reflections. And because they unfold internally as well as externally, they put the Lover onto a revelatory path that unveils things normally hidden from view, whether because too small, too buried, or outside one's consciousness.[22]

Geometries of Nature

Besides delivering fascinating optical spectacles, the stones of the quartz family stood out for their elegant formal configurations. Pliny already praised rock crystal's chiseled peaks and smooth hexagonal faces as an accomplishment of Nature's form-inventing bravura, stressing that "no craftsmanship could achieve the same effect."[23]

17 Bartholomaeus Anglicus, *De rerum proprietatibus*, 16.30 (Frankfurt am Main: Minerva, 1964), 731.

18 Vincent Ilardi, *Renaissance Vision from Spectacles to Telescopes* (Philadelphia: American Philosophical Society, 2007), 8–11.

19 For an older but still valuable survey, see George Frederick Kunz, *The Curious Lore of Precious Stones* (Philadelphia: J. B. Lippincott, 1913), 176–225.

20 Guillaume de Lorris and Jean de Meun, *The Romance of the Rose*, ll.1537–70, trans. Charles Dahlberg (Princeton: Princeton University Press, 1971), 51.

21 Still fundamental is David C. Lindberg, *Theories of Vision from al-Kindi to Kepler* (Chicago: Chicago University Press, 1976).

22 As discussed by Marisa Galvez, "Dark Transparencies: Crystal Poetics in Medieval Texts and Beyond," *Philological Quarterly* 93, no. 1 (2014): 15–42. This passage has elicited much commentary, from medievalists to Lacan. For a good summary, see Suzanne Conklin Akbari, *Seeing Through the Veil: Optical Theory and Medieval Allegory* (Toronto: University of Toronto Press, 2004), 55–57 and 96–98.

23 Pliny, *Natural History*, 37.26, 183. See comments in Crowley, "Crystalline Aesthetics," 222–23.

Isidore of Seville formalized the suggestion of an inherent regularity. Foreshadowing modern notions of crystallization, he proposed that the stone's specific form (*species*) was a byproduct, albeit an essential one, of the lengthy process of petrification.[24]

True to the rationalizing spirit of the scholastic age, Thomas of Cantimpré wanted an explanation for this marvel of perfection in an imperfect world (more accurately, a world made imperfect through human sin). He answered by way of similitudes. Think of a honeycomb or a stack of candles held tightly. Toward the outer rim, the cells and candles retain their spherical shape as there is enough space for them to expand to their full potential, whereas toward the center they are forced into a more economical format.[25] Thomas surmises that a comparable situation must have obtained during the formative stages of the *iris* when powerful vaporous exhalations compressed water and earth into a coherent solid. For the Flemish Dominican, such an ideal configuration could only be the result of intelligent design, though we might say that he had an excellent intuitive understanding of hexagonal tiling as a most efficient spatial organization—hence its wide distribution in nature, from honey to snow, ice, and quartz.

In a French translation of Bartholomaeus Anglicus's encyclopedia, we can see how an artist rephrased that distinctive hard-edged geometry (see fig. 5). The large-format copy of the *Livre des propriétés des choses* was commissioned by the French royal official Tanneguy IV du Chastel (d. 1477). The visual program advertises the seventy-odd stones described in Book 16 not as rough *naturalia* but as desirable *artificialia*. Mounted into brooches and set on rings pinned to the wall, they are treated as if precious heirlooms kept in a jewel box. The *iris*, tinted in a shimmering gray, consequently appears as a faceted planar cabochon; still, it is the only item to be singularized by means of hexagonal contours. A manuscript that predates the codex by several decades offers a more decidedly volumetric approach to crystal prisms. In this case, the text is the early medieval encyclopedia *De rerum naturis* (On the Nature of Things, also known by the older title *De universo*). Its author, Hrabanus Maurus (d. 856), served as abbot of the prestigious monastic house at Fulda before being elected to the episcopal See of Mainz, and also was a key

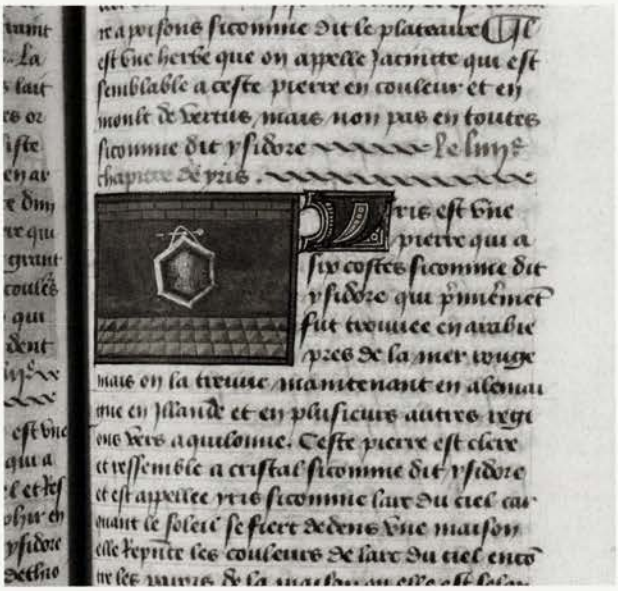

Fig. 5 Hexagonal *iris*, Bartholomaeus Anglicus, *Livre des propriétés des choses*, trans. Jean Corbechon, France, ca. 1470–80. Paris, Bibliothèque nationale de France, MS fr. 22532, fol. 231r

player in the cultural *renovatio* fostered by Carolingian emperors. The present copy was commissioned a full six centuries later by Louis VII the Bearded of Bavaria-Ingolstadt (d. 1447), a pushy political leader, voracious art lover, and discerning bibliophile all in one. For the section on *crystallus*, this illuminator settled on a stony tableau devoid of human presence, recruiting eight objects to serve as both the expressive and inexpressive subjects of representation (see Plate 13a).[26] Shimmering flecks dot the crystals' niveous skin, a neat pictorial device for the way it evokes a watery sheen unencumbered by color. More importantly, the intentional chromatic minimalism allows to code them as *formed matter*.[27] Couched in the then-novel and still somewhat approximate perspectival idiom, the pointy triangle and diamond, spheres and ovals, cubes and cuboids look as if they had been designed by the pencil of nature. In reality, they quite expertly mimic the vocabulary of forms developed by coeval gem cutters, which means that this image too passes off fabricated objects as things-of-nature; or, at least, blurs clear-cut boundaries between artificially manufactured and

24 Isidore of Seville, *Etymologies*, 16.13.1, 325.

25 Thomas of Cantimpré [Thomas Cantimpratensis], *Liber de natura rerum*, 14.41, ed. Helmut Boese (Berlin: De Gruyter, 1973), 364. The author added this explanation to a revised version, finished ca. 1256. There are as of yet no modern translations of this work.

26 I borrow these terms from James Elkins, "Art History as the History of Crystallography," in *The Domain of Images* (Ithaca, NY: Cornell University Press, 1999), 13.

27 Andreas Kühne, "Stereometrische Darstellungen in der Renaissance vor dem Hintergrund der Vorgeschichte der Kristallographie," in *Toward a History of Mineralogy, Petrology, and Geochemistry*, ed. Bernhard Fritscher and Fergus Henderson (Munich: Institut für Geschichte der Naturwissenschaften, 1998), 65–80.

naturally engineered creativity.[28] In the end, the seemingly unassuming image makes a radical conceptual claim: that precious stones, and crystals in particular, can be apprehended in their morphologies and classed accordingly. That intuition, it bears stressing, would not come to full fruition until the development of the science of crystallography in the eighteenth century and the ensuing redirection of mineral taxonomies from color to form.

As if to prove that even the history of science has its anachronic moments, it turns out that the pioneering image revisited a much older original. To see what it looks like we move back to the second decade of the eleventh century and to the southern Italian abbey of Montecassino, an intellectual powerhouse and birthplace of Benedictine monasticism. Although no consensus has emerged around the existence of an earlier Ottonian, Carolingian, Isidorian, or late antique model, we know that the enlightened abbot Theobald (d. 1035) oversaw the production of this luxurious book, perhaps intending it as a gift for a royal benefactor. Barring new conclusive evidence, this Romanesque reissue of Hrabanus's encyclopedia must be regarded as an original effort based on the adoption and adaptation of existing compositions. As a prime witness of the meandering *Nachleben* of ancient visual forms and representational formulas, its extensive pictorial program captivated the attention of a distinguished roster of art historians of Warburgian sensibility, from Adolph Goldschmidt and Fritz Saxl to Erwin Panofsky and Rudolf Wittkower.[29]

But the Montecassino cycle also accommodates ex nihilo creations, among which we must count, I believe, several of the nine colored drawings that punctuate Book 17, "On Stones and Metals." Together, they invite viewers on an unprecedented geological tour. Visualizing everything from dust to metals, some pictures center on an activity (blowing glass, cutting a block of marble) while others look out from the page in stony stillness. The initial impression made by the three forms that embody *crystallus* is disappointing, a feeling compounded by their formal proximity to gems and pearls. In the case of pearls and crystal (see fig. 6), the colors are pale, but that washed-out aspect is a consequence of incompletion rather than a deliberate solution to the problem of picturing transparency. As it were, the same palette was used for the more than 300 miniatures that enrich Cod. Casin. 132, whether the intent was to embody celestial beings, summon back to life ancient deities, flesh out man-made goods, or conjure into visual existence a prodigious collection of natural objects. Our perception starts to change once we realize that in contrast to the unifying chromatic scheme, the monastic illuminator invented a specific grammar of forms to identify the mineral realm. It is the same stark lexicon of circles, triangles, diamonds, and squares reprised in the fifteenth-century copy, except that in this latter case the shapes have grown into full-blown three-dimensional entities. In the present iteration, nothing betrays a desire to approximate what a rock looks like: the forms remain stubbornly abstract. Yet for all their mimetic shortcomings, these may well be the first "stones" to have been conceived as forming a distinct rubric of natural objects—objects crystallized, visually if not physically, into a *species* that is exclusively their own.[30]

The diamond and circles of the Romanesque Hrabanus codex are special for one additional reason. Their literalism, laconic as it is, declares a certain autonomy of the visual, even as it is firmly anchored to, and embedded in, a text. Hrabanus very much thought of his encyclopedic project as a labor of love for God, the creator of the wonderfully diverse world reflected in his book. More specifically, he intended the *De rerum naturis* as a primer for the intricate art of biblical exegesis aimed at directing the minds of young monks and other readers prone to cling to the surface of things toward loftier goals. What mattered to him was meaning, not being. He followed Isidore of Seville faithfully for the descriptive data yet felt that the terse skeleton of the *Etymologies* lacked hermeneutic depth. *Res* needed discursive padding, some *mystica significatio* that could convert their innate muteness into intelligible speech acts. For the allegorical interpretation of gemstones, the Carolingian churchman relied on Bede's gloss of the Heavenly Jerusalem in his early eighth-century commentary on the Apocalypse. As the typological counterpart to the breastplate of the High Priest described in Exodus 28:17–21, the celestial city is built on a foundation of twelve precious stones (Rev. 21:18–21). We can take the *beryllus* as an example of the tropological approach championed by Bede, Hrabanus, and subsequent writers who turned to the two scriptural sequences as their main source of lithic inspiration. The beryl signifies wisdom, these authors contend, for just as it refuses to shine unless cut into a hexagon, so virtuous behavior requires refining through the

28 For a good summary, see Ronald W. Lightbown, *Mediaeval European Jewellery, with a Catalogue of the Collection in the Victoria and Albert Museum* (London: Victoria and Albert Museum, 1992), 11–17.

29 Summarized by Diane O. Le Berrurier, *The Pictorial Sources of Mythological and Scientific Illustrations in Hrabanus Maurus' "De rerum naturis"* (New York: Garland Publishing, 1978). Also see the facsimile edition under the direction of Guglielmo Cavallo, *Rabano Mauro, De rerum naturis. Cod. Casin. 132, Archivio dell'Abbazia di Montecassino* (Pavone Canavese: Priuli & Verlucca, 1994).

30 As recognized by Adolph Goldschmidt, "Frühmittelalterliche illustrierte Enzyklopädien," *Vorträge der Bibliothek Warburg* 3 (1923): 219.

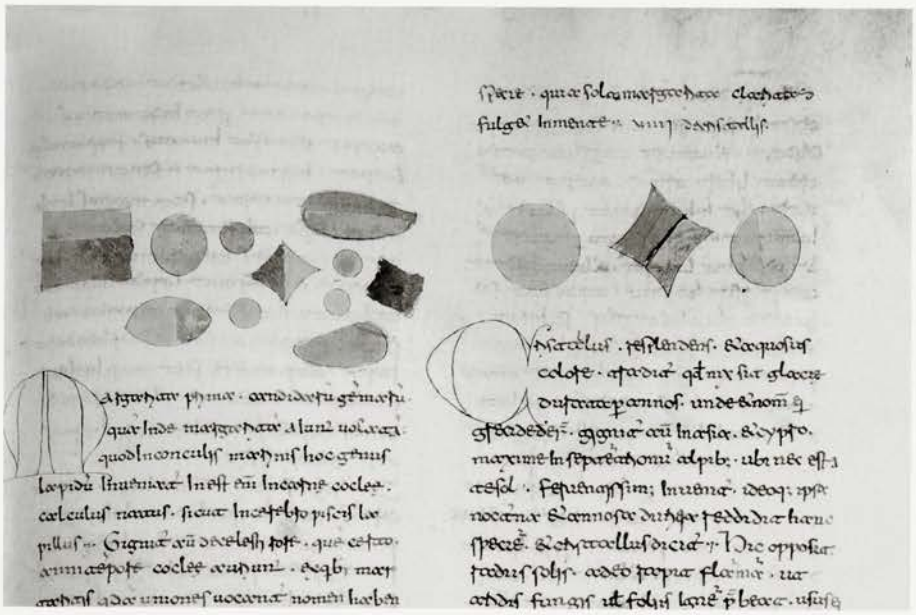

Fig. 6 *De crystallis*, Hrabanus Maurus, *De rerum naturis*, Montecassino, 1020s. Montecassino, Archivio e Biblioteca dell'Abbazia, Cod. Casin. 132, fol. 427r

"completion of works," six being the number of days it took for the work of Creation to be done. And if a beryl sphere burns the hand of the individual who clutches it, that is akin to a holy man whose exemplary conduct inflames whoever approaches him with spiritual zeal. In similar fashion, the *crystallus* bridges the material and the spiritual. Consistent with a model that at once negates and recognizes the facticity of the things it interprets, the stone's physical properties—transformation from ice, hardness, purity—are mobilized for "mystical" connotations—the sacrament of baptism, the "steadfastness of holy angels," the Incarnation.[31] Of course, the original, highly literate audience of the Montecassino manuscript would read the images alongside the text. Nonetheless, I want to note how the visual synchronizes with the *sensus historicus*, and would even suggest that the vignettes of gems, pearls, and crystals forgo any metaphorics to draw attention to the figurative. And what better than a formless liquid morphed into precisely calibrated silhouettes to celebrate Nature's dexterity in orchestrating formal rigor?

Though rarely depicted, other members of the quartz group disclosed further material paradoxes that propelled them from a humdrum existence into the enchanted realm of the optically edifying and the physically commendable. Remember the *iris* and the creation of a rainbow of colors from a substance as wan as white; or the *alectorius*, purity fashioned from impurity. Meanwhile, the *gelacia* remains willfully impervious to heating techniques of any kind, honoring its origin in hail, as implied by its Greek name *chalazias*. Not surprisingly, lapidaries promote the "Hail stone" as an efficacious neutralizer of heat-induced emotions and drives, such as sexual urges, which, in line with medical opinion, they consider a manifestation of hot humors, not the ugly face of a capital sin. The synthesis between earth and sky is also visibly present in the vitreous blue variety of the "Thunder stone" *ceraunius*. More specifically, that stone marries the mineral and the sidereal inasmuch as it catches, in the words of Isidore of Seville, "the gleam of the stars" when held up to the sky.[32] At the other end of the elemental spectrum, the *enhydros* betrays the groups' aqueous incubation, for it sweats, continuously shedding moisture without decreasing or becoming deliquescent. Where Pliny described it as a round and white stone with liquid trapped inside (rather like a yolk in an egg), Solinus upgraded it into a water-exuding rock, thereby underwriting its status as a mineral *mirabilia*. From his paraphrase—it contains as if a "gushing fountain"—to Marbode's lyrical expression—it perpetually

31 Hrabanus Maurus, *De Universo: The Peculiar Properties of Words and Their Mystical Significance*, trans. Priscilla Throop, 2 vols. (Charlotte, VT: MedievalMS, 2009), 2:177–79. And for a discussion of such meanings in works of art that employ crystal: Stefania Gerevini, "*Christus crystallus*: Rock Crystal, Theology and Materiality in the Medieval West," in *Matter of Faith: An Interdisciplinary Study of Relics and Relic Veneration in the Medieval Period*, ed. James Robinson et al. (London: The British Museum, 2014), 92–99.

32 Isidore of Seville, *Etymologies*, 16.13.5, 326.

distills "tears of lament"— the *enhydros* is one of the many instantiations of the nexus between lapidary physics, poetics, and optics.[33] More disenchantingly, thirteenth-century authors initiated the process that eventually tore the associative web apart by correctly conjecturing that the moisture stems from condensation. In the de-wondering comment by Albert the Great, "the drops do not distil from the substance of the stone at all; but because it is extremely cold, the Air in contact with it continually changes into Water."[34]

The artful imbrication of opposites qualified rock crystal and its siblings as genuine small-scale miracles, those visually arresting and intellectually energizing phenomena that keep the human mind alert to the beauty—physical, formal, and visual—of creation. So airy and yet so solid, so handsomely shaped even though the product of a fluid state of matter, so icy and yet fully a rock, the *crystallus* category stood as a spectacular confirmation that the supreme artifex had a hand in conceiving and designing stones, in the same way that he had planned plants and animals. In turn, medieval artists and their patrons acknowledged rock crystal's mastery over chaos, opacity, and dissolution by using it to envelop hallowed relics and earmarking it for the no less exalted privilege of touching the lips and hands of elite consumers. Going a step further, they also commemorated its icy perfection in paint.

33 Pliny, *Natural History*, 37.190, 319; Solinus, *Collectanea*, 37.24, 258; Marbode of Rennes, *Liber lapidum*, l.602, 146–47.
34 Albert the Great [Albertus Magnus], *Book of Minerals*, 2.2.5, 90–91, where the stone appears as *etindros*.

Plate 12a Pendant with a Cooling Ball, ca. 1500, diam. 4.4 cm. Berlin, Staatliche Museen, Kunstgewerbemuseum, inv. no. F502

Plate 12b The Lover at the Fountain of Narcissus, Guillaume de Lorris and Jean de Meun, *Le Roman de la Rose*, France, mid-14th century. Paris, Bibliothèque Sainte-Geneviève, MS 1126, fol. 10v

Plate 13a Pearls and crystals, Hrabanus Maurus, *De rerum naturis*, Germany, ca. 1425. Vatican City, Biblioteca Apostolica Vaticana, MS Pal. lat. 291, fol. 210v

Plate 13b Fragment of a bowl, Roman or Byzantine, 3rd–5th century CE, diam. 9.5 cm. New York, The Metropolitan Museum of Art; Bequest of Ada Small Moore, 1955, inv. no. 55.135.7