Cooking Niter, Prototyping Nature: Saltpeter and Artisanal Experiment in Korea, 1592–1635

Hyeok Hweon Kang, *Washington University in St. Louis*

Abstract: From experimental philosophers in England to workshop managers in Korea, practitioners across the seventeenth-century world developed new ways of investigating nature while studying saltpeter (potassium nitrate), the chief ingredient of gunpowder. Contrary to global histories that emphasize circulation, however, this early modern convergence had less to do with the fluid movement of knowledge and technology than with the very moments when such movement failed. This essay argues that in Chosŏn Korea (1392–1910) the problem of adopting a Chinese method of manufacture—a "thing that did not work"—proved productive in unexpected ways. In the process of vetting the foreign knowledge, the Korean saltpeterers (artisans and military officers) discovered solutions that suited the local conditions. They also established a mode of experimentalism that used hands-on trials to investigate the natural world, drew on the artisanal techniques of "experiment" (*sihŏm*) and "prototyping" (*kyŏnyang*), and operated in two languages—the vernacular, *hangŭl* script and literary Sinitic.

During the late months of 1630, a Korean envoy mission en route to China witnessed a strange occurrence. That year, in the midst of a raging war between Ming China (1368–1644) and the Jurchens (after 1635 called Manchus), Chŏng Tuwŏn 鄭斗源 (1581–1642) led the Koreans to Beijing—not through the usual overland route, but by sailing first to the Shandong peninsula and then trekking northward across the coastal lowlands of Hebei province.[1] And thanks precisely to this atypical journey, a breathtaking view would open before their eyes: a hoary

Hyeok Hweon Kang is an assistant professor in the Department of East Asian Languages and Cultures at Washington University in St. Louis. He was a D. Kim Postdoctoral Fellow in the Department of History of Science and Technology at Johns Hopkins University. 1 Brookings Drive, St. Louis, Missouri 63130 USA; hhkang@wustl.edu.

Acknowledgments. I would like to thank Sun Joo Kim, Yulia Frumer, Steve Walton, Florin Stefan-Morar, and the two anonymous referees for *Isis* for their transformative feedback on this essay. I am likewise grateful to the members of the Early Modern Science Group at the Consortium for the History of Science, Technology, and Medicine; the Chosŏn History of Science Seminar at Seoul National University; and the Johns Hopkins Program in the History of Science, Technology, and Medicine. I wish to express my gratitude to Victor Seow, Jongsik Lee, and Kanghun Ahn for their intellectual stimulation, and to the D. Kim Foundation and the Northeast Asia Council at the Association for Asian Studies for their generous support.

[1] For a detailed study of the Korean envoy mission in 1630 see Lim Jongtae, "Rodrigues the Gift-Giver: A Korean Envoy's Portrayal of His Encounter with a Jesuit in 1631," *Korea Journal*, 2016, 56:134–162. See also Lim, "Tributary Relations between the Chosŏn and Ch'ing Courts to 1800," in *The Cambridge History of China*, 15 vols., Vol. 9: *The Ch'ing Dynasty to 1800*, Pt. 2, ed. Willard J. Peterson (Cambridge: Cambridge Univ. Press, 2016), pp. 146–196.

ISIS, volume 113, number 1, March 2022.
 https://doi.org/10.1086/718283

efflorescence that covered the ground, stretching all across the vast lowlands. As Chŏng's travelogue suggests, the Koreans stopped, took in the sight, and probably ran the crystalline soil through their hands. Chŏng, for his part, examined the substance closely and likened it to the transparent granules of camphor. Before long, however, the mission consulted the locals and learned of its true nature: a seasonal occurrence of saltpeter or—as the envoy put it—"niter efflorescence" (K. *yŏmch'ohwa* 焰硝花).[2]

This little-known discovery of Chinese efflorescence was a milestone in Korea's experimentation with saltpeter, also known as niter. A chief ingredient of gunpowder and also used for making pigments and treating gemstones, saltpeter was a crucial resource for the Chosŏn dynasty (1392–1910) to secure domestically.[3] The peculiar substance, however, was difficult to produce in sufficient quantities. In Korea—and across the early modern globe—saltpeterers scraped together "nitrous soil" from old walls, latrines, and outhouses; percolated that soil through settling tubs to obtain a liquid; and refined the solution through multiple fuel-consuming steps of boiling and cooling (fractional crystallization)—all for a meager yield.[4]

There was, in other words, never enough saltpeter. And it is scant wonder that the embassy—when presented with a seemingly limitless source of niter—should seek to take advantage: upon encountering the crystalline deposits, they scooped up a little and returned home with a soil "sample" (K. *kyŏnyang*; this expansive term is discussed below).[5] Apparently they also conveyed some new knowledge on niter-making, because within the next few years a new method of boiling saltpeter, "brought" from the 1630 mission, spread across the peninsula.[6]

---

[2] Chŏng Tuwŏn 鄭斗源, *Choch'ŏn ki chido* 朝天記地圖 (*Cartographic Record of a Mission to the Celestial Court*), in *Yŏnhaengnok sŏnjip poyu* 燕行錄選集補遺, 2 vols. (1630–1631; rpt., Seoul: Taedong munhwa yŏn'guwŏn, 2008), Vol. 1, pp. 117–202: "焰花産於海邊大野中, 其狀如小腦香者, 以此煮爲焰硝, 自景州至帝京, 處處産出, 不可勝數." On the availability of saltpeter as ground efflorescence in Hebei, Henan, and Shandong see Yao Kuan 姚寬, *Xixi congyu* 西溪叢語 (*Collected Conversations with Yao Kuan*) (12th century; rpt., Beijing: Zhonghua shu ju, 1993), pp. 110–112. Anthony Butler and John Moffett explain that the seasonal efflorescence is an exceptionally prolific manifestation of the natural nitrogen cycle. When organic matter decays in the ground, bacterial enzymes transform it first into ammonia and then into nitrate—which in some climatic conditions then emerges as ground efflorescence. See Anthony Butler and John Moffett, "Saltpetre in Early and Medieval Chinese Medicine," *Asian Medicine*, 2009, 5:173–185, esp. p. 177.

[3] On the various uses of saltpeter in Korea see *Sejong sillok* 世宗實錄 (*Veritable Records of Sejong's Reign*), in *Chosŏn wangjo sillok* 朝鮮王朝實錄 (*Veritable Records of the Chosŏn Dynasty*) (hereafter cited as **CWS**), ed. Kuksa p'yŏnch'an wiwŏnhoe (Seoul: T'amgudang, 1955–1958); see the entry for the 22nd day of the 11th month of 1433 (or 1433/11/22; Korean dates will hereafter be given in this form). See also *ibid*., 1432/12/20, 1447/4/8, 1450/3/5.

[4] The method described here—to be distinguished from niter-bedding, discussed later in this essay—was the most basic and prevalent technique across the early modern world. On France see Charles Coulston Gillispie, *Science and Polity in France at the End of the Old Regime* (Princeton, N.J.: Princeton Univ. Press, 1980), pp. 51–54; and Robert P. Multhauf, "The French Crash Program for Saltpeter Production, 1776–94," *Technology and Culture*, 1971, *12*:163–181, esp. p. 163. On England and Sweden see, respectively, Brenda J. Buchanan, "'The Art and Mystery of Making Gunpowder': The English Experience in the Seventeenth and Eighteenth Centuries," in *The Heirs of Archimedes: Science and the Art of War through the Age of Enlightenment*, ed. Brett D. Steele and Tamera Dorland (Cambridge, Mass.: MIT Press, 2005), pp. 233–274, esp. p. 238; and Thomas Kaiserfeld, "Chemistry in the War Machine: Saltpeter Production in Eighteenth-Century Sweden," *ibid*., pp. 275–292, esp. pp. 276–278. On Japan see studies on the "aged-soil method" (J. *kodohō* 古土法): Itagaki Eiji 板垣英治, "Kagahan no kayaku: enshō oyobi iō no seisan" 賀藩の火薬: 塩硝及び硫黄の生産 ("Gunpowder of Kaga Domain: Production of Potassium Nitrate and Sulfur for Gunpowder"), *Nippon kaīki kenkyū* 日本海域研究, 2002, 33:111–127, esp. p. 112; and Nozawa Naomi 野澤直美 *et al*., "Enshō zukuri 'Kodohō' no shigaku chōsa to jikkenteki kenshō nitsuite" 煙硝づくり '古土法'の史学調査と実験的検証について, *Kusuri shigaku zasshi* 薬史学雑誌, 2019, 54(2):94–103. On Korea see Min Pyŏngman 민병만, *Han'guk ŭi hwayak yŏksa: yŏmch'o esŏ Tainŏmait'ŭ kkaji* 한국의 화약역사: 염초에서 다이너마이트까지 (*The History of Explosives in Korea*) (Seoul: Iworkbook, 2009), pp. 260–287.

[5] *Injo sillok* 仁祖實錄 (*Veritable Records of Injo's Reign*), in *CWS*, 1631/7/12. See also Cho Kyŏngnam 趙慶男, *Sokchamnok* 續雜錄 (*Sequel to the Miscellaneous Writings during the War*), in *Chōsen gunsho taikei* 朝鮮群書大系, Vols. 7–8 (1582–1638; rpt., Keijō: Chōsen Kosho Kankōkai, 1910), Vol. 7, p. 78a: "故見樣次, 以又得鹽硝數兩而來."

[6] *Injo sillok*, 1633/10/8: "新方煮硝之法, 一一傳習 . . . 我國初無焰硝, 貿於中朝而用之. 鄭斗源奉使北京, 學得煮法而來, 仍令傳習, 以廣其用."

The movement of Chinese saltpeter-making to Korea, however, was far from a smooth process. One obstacle was that niter efflorescence—a highly concentrated form of saltpeter—was never found on the peninsula.[7] This meant, in turn, that the method supposedly introduced thanks to the mission could not have been a simple, fluid transfer of knowledge, rooted as the Chinese process was in the locally sourced material. How then did the Korean saltpeterers manage? While foreign knowledge of niter-making did contribute to the new method, it was, it is critical to note, compiled from multiple sources—not just Chinese, but Japanese and European as well. It also had to be vetted through rigorous hands-on trials, after which little remained that was useful. Yet, in the very process of experimentation, Korean practitioners set out to create their own niter efflorescence "artificially," successfully imitating the natural processes at work in Hebei.

What guided the practitioners was the local, shop-floor practice of *kyŏnyang*, or what I translate as "prototyping." "*Kyŏnyang*" refers to the artisanal practice of using drawings, models, numerical specifications, and technical writing to convey a craft idea. Employed in the government workshops since at least the fourteenth century, the technique saw further elaboration in the seventeenth century, especially in arsenals and military shops, where it passed into the hands of the workshop managers (military officers) who supervised the artisans.[8] At the Chosŏn nitrary, for example, artisans and officers used the aforementioned soil sample as, literally, the "target" of reproduction.[9] And as they approached the soil as a craft object—to be made, manipulated, and reverse-engineered—they found solutions that fit the Korean conditions. In doing so, they also developed a way of knowing nature that emphasized hands-on trials, drew on the artisanal techniques of "experiment" (*sihŏm*) and "prototyping" (*kyŏnyang*), and mobilized two languages—the vernacular, *hangŭl* script and literary Sinitic.

This story of Korean niter challenges global histories that emphasize circulation in the making of the early modern sciences. In *Matters of Exchange*, Harold Cook famously argued that modern science owed its epistemological foundation to the rise of global commerce—that is, the increasing traffic across the world of natural objects and their associated knowledge. These "matters of facts," he showed, "had the advantage of being easily communicated from person to person, penetrating cultural borders," and their accumulation—especially in the Netherlands and western Europe—led to the elevation of "objectivity" in the practices of early modern anatomy and botany.[10]

Recently, however, historians of science have eschewed the focus on "things that work" and have turned instead to the neglected cases when alien knowledge proves "sticky," "rooted," or "frictional" in its movement.[11] Offsetting his earlier emphasis on circulation, Cook first suggested using "sticky" as a metaphor for probing such cases. Then Marcy Norton and Dorothy Ko

---

[7] Yi Kyugyŏng 李圭景, *Oju yŏnmun changjŏn san'go* 五洲衍文長箋散稿 (*Oju's Scattered Drafts of Rough Writings and Long Notes*) (19th century; Seoul: Seoul Taehakkyo Kojŏn Kanghaenghoe, 1993), Vol. 1, p. 1006; and Yi Kyugyŏng, *Oju sŏjong pangmul kobyŏn* 五洲書種博物考辨, trans. Ch'oe Chu 최주 (1834; Seoul: Hagyŏn Munhwasa, 2008), pp. 178–180.

[8] Hyeok Hweon Kang, "Crafting Knowledge: Artisan, Officer, and the Culture of Making in Chosŏn Korea, 1392–1910" (Ph.D. diss., Harvard Univ., 2020), pp. 155–204.

[9] "*Kyŏnyang*" is a vernacular Korean concept that means "to target," as in leveling one's eye at an object. For a Korean artisan, "targeting" also had a secondary meaning—i.e., to capture an object's shape by placing it against a backdrop and tracing its perimeter. *Ibid*., pp. 125.

[10] Harold J. Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven, Conn.: Yale Univ. Press, 2007), pp. 16–20, 411. See also Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900* (New York: Palgrave Macmillan, 2007).

[11] Kapil Raj and Mary Terrall discuss potential problems with the focus on circulation. See Kapil Raj and Mary Terrall, eds., "Circulation and Locality in Early Modern Science," special issue, *British Journal for the History of Science*, 2010, 43:513–623. For other critiques of circulation narratives see Warwick Anderson, "Remembering the Spread of Western Science," *Historical Records of Australian Science*, 2018, 29:73–81; and Fa-Ti Fan, "The Global Turn in the History of Science," *East Asian Science,*

examined, respectively, the (im)mobility of chocolate and the inkstone. However, as Francesca Bray, Barbara Hahn, John Bosco Lourdusamy, and Tiago Saraiva noted in their emphasis on the "rootedness" of crops, "the study of things that do not travel ('stickiness studies'), with all that such refusals or failures hint about never taking mobility for granted, is still in its infancy."[12] The notion that fluid things—often foreign, global, and novel—necessarily spread useful knowledge is thus being challenged. But the alternative story—of how sticky things, entangled as they are with the local and the vernacular, could also forge early modern science—is yet to be fully and convincingly told.

Saltpeter makes a great subject for exploring this alternative path to scientific knowledge: as mentioned, niter was difficult to source, and in many low-yielding regions across the world "a specter of scarcity" led practitioners to experiment with foreign methods of production, often unsuccessfully.[13] The English in the seventeenth century also grappled with artificial niter. Mimicking German practices of establishing and tending niter-beds, or nitraries, artisans in England collected heaps of rotting earth and mixed it with dung and urine to obtain nitrous soil (see Figure 1).[14] This method was difficult to establish, however, and the domestic trade crumbled under cheap alternatives from India (another place where natural saltpeter was found as ground efflorescence).[15] In a similar vein, Sicilians during this period made saltpeter out of manure-enriched soils. But while their niter-beds proved more successful, an abundance of niter was secured only in the 1780s, when a "natural nitrary" (It. *nitriera naturale*) was discovered belatedly in the dolines of southern Italy.[16] Absent cheap imports and windfall discoveries, other regions could not but continue their trials. In early modern Japan, local trials led to a distinctive practice in the Gokayama region, where villagers "farmed" nitrous soil with silkworm excreta.[17] And as late as the eighteenth century both the Swedes and the French established nitraries: the Swedish War College implemented niter-bedding after 1747; and French chemists, notably Antoine Lavoisier (1743–1794), synthesized Swedish practices with local French ones, albeit with only a "*peu de success*."[18]

Technology, and Society, 2012, 6:251–253. See also Pamela H. Smith, "Nodes of Convergence, Material Complexes, and Entangled Itineraries," in *Entangled Itineraries: Materials, Practices, and Knowledges across Eurasia*, ed. Smith (Pittsburgh: Univ. Pittsburgh Press, 2019), pp. 5–24, esp. pp. 22–23.

[12] Cook, *Matters of Exchange* (cit. n. 10); Marcy Norton, *Sacred Gifts, Profane Pleasures: A History of Tobacco and Chocolate in the Atlantic World* (Ithaca, N.Y.: Cornell Univ. Press, 2008); Dorothy Ko, *The Social Life of Inkstones: Artisans and Scholars in Early Qing China* (Seattle: Univ. Washington Press, 2016); and Francesca Bray, Barbara Hahn, John Bosco Lourdusamy, and Tiago Saraiva, "Cropscapes and History," *Transfers*, 2019, 9(1):20–41, on p. 22.

[13] I adapt this phrase from John Lee's discussion of the "specter of timber scarcity": John S. Lee, "Postwar Pines: The Military and the Expansion of State Forests in Post-Imjin Korea, 1598–1684," *Journal of Asian Studies*, 2018, 77:319–332, on p. 320.

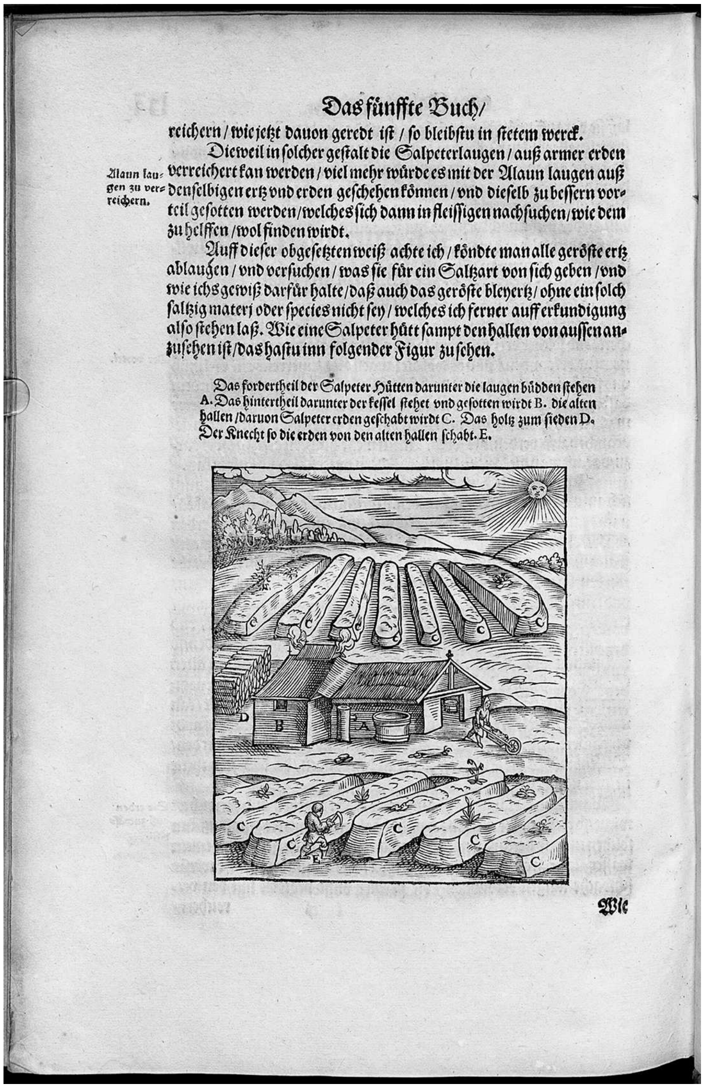
[14] A. R. Williams, "The Production of Saltpetre in the Middle Ages," *Ambix*, 1975, 22:125–133; and Haileigh Robertson, "Reworking Seventeenth-Century Saltpetre," *ibid.*, 2016, 63:145–161.

[15] Buchanan, "'Art and Mystery of Making Gunpowder'" (cit. n. 4), pp. 238–240; and Seymour H. Mauskopf, "Chemistry in the Arsenal: State Regulation and Scientific Methodology of Gunpowder in Eighteenth-Century England and France," in *Heirs of Archimedes*, ed. Steele and Dorland (cit. n. 4), pp. 293–330, esp. p. 302. See also David Cressy, *Saltpeter: The Mother of Gunpowder* (Oxford: Oxford Univ. Press, 2013).

[16] The naturalists Giuseppe Maria Giovene (1753–1837) and Alberto Fortis (1741–1803) together discovered vast deposits of saltpeter in the Murge plateau in Apulia. See Giuseppe Maria Giovene, "Della nitriera naturale di Molfetta detta il Pulo," in *Raccolta di tutte le opera del chiarissimo cavaliere Giuseppe Maria Giovene*, Vol. 2: *Memorie fisiche* (Bari: Cannone, 1840), pp. 583–602.

[17] This knowledge was a carefully guarded secret until the mid-eighteenth century. Other producers in Japan continued to practice the traditional methods (*kodohō*) of scraping walls and outhouses. See Itagaki, "Kagahan no kayaku" (cit. n. 4), pp. 112–119. See also Itagaki Eiji 板垣英治, "Gokayama no Ensho" 五箇山の塩硝 ("Gokayama's Saltpeter"), *Kanazawa daigaku daigaku kyōiku kaihō sentā kiyō* 金沢大学大学教育開放センター紀要, 1998, *18*:31–42.

[18] Kaiserfeld, "Chemistry in the War Machine" (cit. n. 4), pp. 276–278; Gillispie, *Science and Polity in France at the End of the Old Regime* (cit. n. 4), pp. 66–73; Multhauf, "French Crash Program for Saltpeter Production" (cit. n. 4), pp. 171–180; and Mauskopf, "Chemistry in the Arsenal" (cit. n. 15), p. 307. For a more positive evaluation of French niter-bedding see Patrice Bret, "The Organization of Gunpowder Production in France, 1775–1830," in *Gunpowder: The History of an International Technology*, ed. Brenda J. Buchanan (Claverton Down: Bath Univ. Press, 1996), pp. 261–274.



Das fünffte Buch/

reichern/ wie jetzt dauon geredt ist / so bleibstu in stetem werck.

Dieweil in solcher gestalt die Salpeterlaugen / auß armer erden verreichert kan werden / viel mehr würde es mit der Alaun laugen auß denselbigen ertz vnd erden geschehen können / vnd dieselb zu bessern vorteil gesotten werden/ welches sich dann in fleissigen nachsuchen/ wie dem zu helffen / wol finden wirdt.

Alaun laugen zu verreichern.

Auff dieser obgesetzten weiß achte ich / köndte man alle geröste ertz ablaugen / vnd versuchen / was sie für ein Saltzart von sich geben / vnd wie ichs gewiß darfür halte/ daß auch das geröste bleyertz/ ohne ein solch saltzig materj oder species nicht sey / welches ich ferner auff erkundigung also stehen laß. Wie eine Salpeter hütt sampt den hallen von aussen anzusehen ist/ das hastu inn folgender Figur zu sehen.

Das fordertheil der Salpeter Hütten darunter die laugen büdden stehen A. Das hintertheil darunter der kessel stehet vnd gesotten wirdt B. die alten hallen /daruon Salpeter erden geschabt wirdt C. Das holtz zum sieden D. Der Knecht so die erden von den alten hallen schabt. E.

Wie

Figure 1. Niter beds in Germany. The hut in the middle is a refinery where nitrous soil was percolated and refined, surrounded by plantations of rotting earth mixed with dung and urine. Source: Lazarus Ercker, *Treatise on Ores and Assaying* (Frankfurt am Main, 1580), Bavarian State Library, Munich, Germany, Druck 282 S, p. 133.

I bring the case of Chosŏn to bear on the following argument: that examining the story of niter efflorescence on the peninsula—a "thing that did not work"—demonstrates well the frictions that can arise in the transit of natural knowledge and, subsequently, the ways in which local artisans and practitioners sought to resolve them. Centering this historical experience shows us, first, the fallibility of cosmopolitan knowledge and the limitations of global commodity circulation in shaping and spreading science. It also reveals the epistemic culture of small-scale, localized producers who defined their own engagement with the early modern knowledge "market," seeking not so much to participate in or contribute to it as discretely to appropriate its fruits for their specific needs.

KOREA AND FOREIGN NITER IN THE SEVENTEENTH CENTURY

Chŏng's 1630 mission to China needs to be contextualized within a half-century of Korean engagement with foreign niter. During a turbulent period of international war, from 1592 to 1635, saltpeter arose as a significant object of inquiry at the Chosŏn court. Bracketed by two conflicts—the East Asian War (1592–1598) and the first phase of the Ming–Manchu Wars (1618–1683)—this was a time when the Koreans were exceptionally eager to adopt new military technology.[19] In particular, suffering severe shortages of saltpeter, they sought to coopt foreign (especially Chinese) knowledge of niter-making.[20]

Korean investigations into foreign niter began in earnest during the East Asian War. An international conflict waged between the Japanese invaders of the peninsula, on the one hand, and its defenders and their Ming allies, on the other, this war created new movements of people, thrusting into the Chosŏn camp thousands of Japanese prisoners of war and defectors as well as Chinese allies—some who offered temporary help and some who deserted permanently.[21] From early on, the court recognized these foreigners as important sources of knowledge about niter. To identify, test, and coopt the saltpeterers in the group, they deployed interpreters and artisans in conjunction.[22] The protocol was to dispatch the investigators, inquire after the foreigners' skills, and have them demonstrate on the shopfloor for evaluation. If deemed useful, the Korean investigators would then "exhaustively obtain their methods": the artisans would roll up their sleeves and apprentice alongside their foreign peers. For their part, the interpreters facilitated the conversations and wrote down recipes; compilations of both Japanese and Chinese gunpowder recipes survive to this day.[23]

Information was also extracted from other sources, voluntarily or not. Availing themselves of the alliance with the Ming, the Koreans repeatedly approached Chinese officials and generals regarding their knowledge of saltpeter-making. If these were unwilling to share their knowledge, their underlings—artisans and household servants—were bribed for information.[24] With regard to Japan, unexpected "spies," such as Korean turncoats and captives of war who were "repatriated,"

---

[19] On the East Asian War see Kenneth M. Swope, *A Dragon's Head and a Serpent's Tail: Ming China and the First Great East Asian War, 1592–1598* (Norman: Univ. Oklahoma Press, 2018); and James B. Lewis, ed., *The East Asian War, 1592–1598: International Relations, Violence, and Memory* (New York: Routledge, 2017). On the Ming–Manchu Wars see Frederic E. Wakeman, *The Great Enterprise: The Manchu Reconstruction of Imperial Order in Seventeenth-Century China* (Berkeley: Univ. California Press, 1985).

[20] Niter was a crucial subject of study for various reasons: these wars employed a large quantity of firearms, which increased the demand for gunpowder; used new types of gunpowder with a high content of saltpeter; and contributed to niter scarcity on the peninsula by jeopardizing imports from China. See Hŏ T'aegu 허태구, "17 segi Chosŏn ŭi yŏmch'o muyŏk kwa hwayak chejobŏp paldal" 17세기 조선의 염초무역과 화약제조법 발달 ("Niter Trade and the Development of Gunpowder-Making Techniques in Seventeenth-Century Chosŏn"), *Han'guk saron* 한국사론, 2002, 47:203–254.

[21] Regarding the Japanese captives alone, estimates range from five to ten thousand people. Records of processing about six hundred of them are found in the court annals. See Han Munjong 한문종, *Chosŏn chŏngi hyanghwa, sujik Waein yŏn'gu* 조선전기 향화 수직 왜인 연구 (*Migrant and Officially Appointed Japanese in the Early Chosŏn*) (Seoul: Kukhak Charyowŏn, 2001), pp. 145–151.

[22] *Sŏnjo sillok* 宣祖實錄 (*Veritable Records of Sŏnjo's Reign*), in *CWS*, 1593/2/10, 1593/3/11. For an example of Korean interpreters interrogating Japanese captives see *ibid.*, 1595/4/19. On the institution of Chosŏn interpreters see Sixiang Wang, "Chosŏn's Office of Interpreters: The Apt Response and the Knowledge Culture of Diplomacy," *Journal for the History of Knowledge*, 2020, *1*(1):1–15.

[23] *Sŏnjo sillok*, 1593/3/11 (quotation): "焰硝煮取之法, 未能傳習, 今次生擒倭人, 知其煮法云 . . . 率匠人盡得其法." On vetting foreigners with useful knowledge and asking them to demonstrate it see *ibid.*, 1594/7/14: "其中有煮焰硝之倭, 此則使之留此, 煮焰以試, 而使我國之人, 傳習合藥等事"; 1594/8/2: "其中 . . . 三倭, 稍解煮焰硝之法, 此倭則姑留京中, 厚其衣食, 使之煮焰硝硝, 以試其能何如." For an example of recipe writing see *ibid.*, 1595/4/19. There are many other examples: *ibid.*, 1593/6/16, 1593/7/9, 1594/3/21, 1594/7/24, 1595/3/5, 1596/9/20.

[24] *Ibid.*, 1594/1/8, 1594/5/23, 1595/2/17.

came in handy. One example is an unnamed woman who had learned niter-making in Japanese captivity and whose methods were studied carefully, like those of the foreigners.[25]

Korea's niter espionage revived in the 1620s and the 1630s, culminating with the discovery of the Chinese efflorescence. During these decades, which coincide with the first phase of the Ming–Manchu Wars, continental East Asia again erupted in violence, wreaking havoc across China and also Korea (i.e., the Manchu invasions of 1627 and 1636). But the situation fueled Chosŏn's niter research in unexpected ways. First, the inflow of refugees from Liaodong (northeast China) supplied new talent: in 1624, the court promised to reward any Chinese migrant whose methods might advance the domestic niter industry, and officer Sŏng Kŭn 成根—manager of saltpeter (*yŏmgamgwan* 焰監官) at the Government Arsenal (*Kun'kisi* 軍器寺)—collected and tested new techniques at the arsenal's own nitrary.[26]

Yet what brought the Koreans to the very source of Chinese niter was envoy missions like Chŏng's, which allowed them to visit, experience, and directly inquire about foreign materials such as niter efflorescence. As mentioned, the passage of the embassy through Hebei was an unprecedented event, thanks to the Jurchens' blocking of the "overland route to Beijing via Liaodong, which the Koreans had trodden for almost two centuries."[27] That the embassy could seize the opportunity when it presented itself, however, was no accident. During this period, when foreign knowledge of niter was not so readily available within the peninsula, countless envoy missions made their way to China and Japan, often harboring ulterior motives of importing—or indeed smuggling—military goods and techniques back to Korea.[28] This was in fact why the 1630 mission to China took care to bring along "connoisseurs" such as Musketeer Pak Muyŏng 朴武永 and Artillery Officer Chŏng Hyogil 鄭孝吉. These were, respectively, a soldier-artisan and a knowledgeable officer who were dispatched with the stated purpose of purchasing niter. But they were also to observe and learn.[29] Pak examined the efflorescence and noted that it resembled what grew "abundantly along the coastline in Inch'ŏn"—he was referring to the natural occurrence of a deceptively similar substance, sal ammoniac (*yosa* 硇砂).[30] Likewise, when Officer Chŏng passed

---

[25] Similarly, a Korean saltpeterer who offered his services to the Japanese was pardoned and coopted, as were other turncoats with useful knowledge. *Ibid.*, 1593/2/10, 1593/2/16.

[26] *Pibyŏnsa tŭngnok* 備邊司謄錄 (*Records of the Border Defense Council*), ed. Kuksa p'yŏnch'an wiwŏnhoe (Seoul: T'amgudang, 1959–1960), 1624/5/15. See also Sŏng Kŭn 成根, *Sinjŏn chach'wi yŏmcho'bang ŏnhae* 新傳煮取焰硝方諺解 (*Vernacular Renditions on the New Method of Saltpeter-Making*), in *Hwap'osik ŏnhae* 火砲式諺解 (*Vernacular Annotations on the Firearms Manual*), ed. Yi Sŏ 李曙 (Seoul: Government Arsenal, 1635), Jangseogak Archives, Seongnam, South Korea (hereafter **JSG Collection**), C5-19, pp. 1b–2a.

[27] Lim, "Rodrigues the Gift-Giver" (cit. n. 1), p. 144.

[28] Kim Yangsu 김양수, "Yŏkkwandŭl ŭi kunbi kanggu" 역관들의 군비 강구 ("Interpreters' Efforts at Military Preparedness"), *Yŏksa wa sirhak*, 2001, *19*:343–380. See also Yonetani Hitoshi 米谷均, "17 seiki zenki Nitchō kankei ni okeru buki yushutsu" 一七世紀前期日朝関係における武器輸出 ("Military Exports in Japan–Korean Relations during the Early Seventeenth Century"), in *Jūshichi seiki no Nihon to Higashi Ajia* 十七世紀の日本と東アジア, ed. Fujita Satoru 藤田覚 (Tokyo: Yamakawa Shuppansha, 2000), pp. 39–68.

[29] Soldiers with an artisanal background would have been sent on these missions. For example, during the Korean embassy to Japan in 1607, three musketeers from the Military Training Agency accompanied the mission to serve as inspectors of items purchased: five hundred muskets from Sakai. See Yonetani, "17 seiki zenki," p. 51. These soldiers worked in conjunction with the petty officers whose job was to purchase niter. There were two types: the artillery officers (*pyŏlp'ajin* 別破陣), who served in the arsenal; and the bannermen (*kip'aegwan* 旗牌官)—also known as instructors (*kyoryŏn'gwan* 教鍊官)—at the agency. *Sŭngjŏngwŏn ilgi* 承政院日記 (*Daily Records of the Royal Secretariat*) (hereafter cited as **SI**), ed. Kuksa p'yŏnch'an wiwŏnhoe (Seoul: T'amgudang, 1961–1977), 1632/6/6, 1625/7/2. For more on the Chosŏn court's encouragement of saltpeter trading with China see Min, *Han'guk ŭi hwayak* (cit. n. 4), pp. 201–202.

[30] Chŏng, *Choch'ŏn ki chido* (cit. n. 2), pp. 117–202: "我國沿海地方, 或有如此之物産之者云." Cf. Cho, *Sokchamnok* (cit. n. 5), Vol. 7, p. 78a. The first clear disambiguation of sal ammoniac from saltpeter occurs in a manuscript written around 1720. See Yi Sip'il 李時弼, *Somul sasŏl* 謏聞事說 (*My Humble Explanation for Things*), Chongno Public Library, Seoul, South Korea, *ch'isuk saengp'ibŏp* 治熟生皮法 (unpaginated).

through Dengzhou, where the Portuguese artillery captain Gonçalo Teixeira Corrêa (ca. 1583–1632) was camping, he encountered the Jesuit João Rodrigues (1561–1633)—a translator for Corrêa—and obtained information about Western firearms and niter-making (I will discuss this later in the essay).[31]

Clearly, then, Koreans were actively gathering information about new methods of niter-making, from sources as varied as Chinese, Japanese, and Portuguese. But how useful were these for local artisans? In the following sections, I examine their response to "ocean niter" (*haech'o* 海硝)—a myth that originated from a misunderstanding of Chinese niter efflorescence—and niter efflorescence proper. These examples show that foreign knowledge proved highly fallible in transit: it led the Koreans into a cul-de-sac from which their only escape was the corrections—and home-grown solutions—made by the local saltpeterers.

OCEAN NITER: THE SEARCH FOR INFINITE SALTPETER

In 1593, only a year after the outbreak of the East Asian War, the Chosŏn court encountered news of a seemingly infinite source of niter: in coastal regions of China such as Shandong and Hebei, a secret technique existed by which ocean water was boiled down to saltpeter, not unlike how salt was made. On hearing this, the reigning King Sŏnjo 宣祖 (r. 1567–1608) was skeptical, and he challenged the official who reported that "[the Chinese] gather up great amounts of ocean foam and boil them." The king retorted in contempt: "That must be for making salt—how could you possibly call it saltpeter?"[32]

Despite his initial reaction, the notion of ocean niter seems to have been too enticing for the king simply to dismiss. In fact, Sŏnjo soon became a zealous proponent: during the rest of 1593, he discussed ocean niter five more times, sent an envoy to China to learn about the method, and declared that any Korean who could figure it out would be rewarded.[33] When all of these efforts failed, the king even wrote to a Ming commander: "I hear that in Shandong, niter is boiled and refined from ocean water, but I do not know if it is credible. . . . I hope you can show us this technique of saltpeter-making in detailed writing."[34]

It's unclear whether the commander produced a useful answer. We do know, however, that for the next decade the Koreans collaborated with the Chinese time and again in attempts to produce ocean niter, which in every instance "bore no results."[35] This continued even after the East Asian War ended. In 1601 the Koreans hired a Ming expert named Sun Long 孫龍 to stay behind and assist in their research. Sun was a gunpowder artisan who transmitted a number of useful techniques to the Koreans, in the course of which he worked with local interpreters, artisans, and managers of saltpeter. Nevertheless, when it came to ocean niter he, too, was unsuccessful, after piloting a workshop in Puan (a county on Korea's southwestern coastline).[36]

These abject failures raise an important question: Did the Ming indeed possess the secret to making niter out of salt water—and the Koreans just couldn't get it right? The historian Sun

---

[31] On the interaction between Chŏng and Rodrigues see Cho, *Sokchamnok*, Vol. 7, p. 78a. See also Lim, "Rodrigues the Gift-Giver" (cit. n. 1), pp. 156–157. At the time, Artillery Captain Corrêa employed Rodrigues and two other interpreters—Simão Coelho and a Chinese *jurubaça* (translator) named Horatio Nerete. His team also included four Portuguese artillerists—Pedro de Quintal, Pedro Pinto, Francisco Aranha, and Francisco Corrêa—and twenty-two Indian and African servants. See Michael Cooper, *Rodrigues the Interpreter: An Early Jesuit in Japan and China* (New York: Weatherhill, 1974), pp. 338, 344; and Manuel Teixeira, "The Church of St. Paul in Macau," *Studia*, 1979, *41–42*:55–111, esp. pp. 101–104.

[32] *Sŏnjo sillok* (cit. n. 22), 1593/2/20: "焰硝之制, 亦何以爲之? 元翼曰: 海潮白漚, 多聚而煮之. 上曰: 此煮鹽之事也, 豈曰焰硝乎."

[33] *Ibid.*, 1593/3/5, 1593/9/8, 1593/9/9, 1593/9/25, 1593/10/22.

[34] *Ibid.*, 1594/1/9: "仄聞山東地方, 則以海水煮煉云, 未知此言信然否 . . . 煮煉之術, 願大人從容詳悉書示." See also *ibid.*, 1594/1/8.

[35] *Ibid.*, 1595/5/25: "都監每欲與唐人試之, 而未見成效."

[36] *Ibid.*, 1595/5/25. For the list of Koreans that Sun collaborated with see *ibid.*, 1601/5/26.

Laichen has affirmed both possibilities on two counts: first, that in Hebei saltpeter and salt have been produced from the same source (salt water) for centuries; and, second, that another "new technique of refining saltpeter from seawater was developed in Shandong possibly due to the stimulus of the Imjin War [also known as the East Asian War]." The knowledge of ocean niter, Sun further noted, was eventually transferred to the Korean nitraries, which had previously toiled under "inferior techniques."[37]

The general acceptance of Chinese importance and success in niter-making is understandable. During the so-called century of warfare (ca. 1550–1683) that ranged across Asia, the Ming was indeed an "empire of saltpetre" that produced vast amounts for global and regional consumption.[38] Yet Sinocentric narratives have led to certain misrepresentations regarding non-Chinese saltpeterers. The first is that they were necessarily second-rate producers. Koreans had produced saltpeter domestically since the late fourteenth century, and they were in constant dialogue with Chinese practitioners. They may thus have been working at the frontier of existing technologies, but their difficulties with production are assumed to be attributable to shortcomings in skill, not soil. More problematic still is the inverse notion that ties the abundant Chinese production to a superiority in technology—and its inevitable diffusion. Existing narratives place an overdue emphasis on events of transmission from China to the rest. But mere records of transfer do not necessarily mean meaningful movements of knowledge, much less the improvement of existing techniques outside of China.[39]

Indeed, the case of saltpeter shows that Chinese practitioners did not hold a magic bullet for the Koreans: ocean niter was a pipe dream. It is impossible to obtain potassium nitrate—today's chemical synonym for saltpeter—by reducing seawater. Dissolved in the vast ocean are more than fifty different elements of varying density, yet apart from sodium chloride (table salt) those elements are present in minute traces. To be sure, after salt is extracted from seawater some potassium sulfate remains in the solution, as is the case with sea bittern, but this is a far cry from saltpeter.[40] And no, ocean water washing up on the shores of Hebei would not have differed significantly from that around the Korean peninsula—a possibility Chosŏn authorities considered as a reason for their persistent failures.[41]

Rather than pointing to an ingenious source of saltpeter, cunningly prepared, the idea of ocean niter was a misinterpretation of how artisans in Hebei and Shandong processed niter efflorescence. We can think of a number of confounding factors that might have deceived casual observers. First, saltpeter—despite having its own distinctive taste—can feel "salty" on the tongue, so the likeness of the two substances may have been misleading.[42] Second, the co-location of salt- and saltpeter-producing regions could also have confused the Koreans: as the historian Sun Laichen highlights (though in erroneous support of his affirmation of ocean niter), "saltpetre-producing areas in Hebei probably coincided with salt-producing areas such as Changlu, Xingji and Changzhou."[43]

---

[37] Sun Laichen, "Saltpetre Trade and Warfare in Early Modern Asia," in *Offshore Asia: Maritime Interactions in Eastern Asia before Steamships*, ed. Kayoko Fujita, Shiro Momoki, and Anthony Reid (Singapore: Institute of Southeast Asian Studies, 2013), pp. 147, 149, 132.

[38] *Ibid.*, p. 167.

[39] *Ibid.*, pp. 132, 149. See also the unwarranted assumption that the Korean saltpeterer Im Mong (discussed later in this essay) was Chinese and the Sinicization of his name as "Lim Meng." *Ibid.*, p. 150.

[40] Heiner Marx *et al.*, "Potassium Sulfate: A Precious By-Product for Solar Salt Works," *Bulletin of the Society of Sea Water Science, Japan*, 2019, 73(2):89–93; and Min, *Han'guk ŭi hwayak* (cit. n. 4), pp. 268–269.

[41] The law of regular salinity has it that the contents of ocean water across the Earth are roughly equivalent. See Min, *Han'guk ŭi hwayak*, pp. 268–269. See also *SI*, 1669/1/6.

[42] I thank Lawrence Principe for his insights here. The conflation of salt and saltpeter was indeed prevalent among practitioners: in Europe as well as East Asia, one way of selecting nitrous soil was to prospect for earths that tasted salty.

[43] Sun, "Saltpetre Trade and Warfare in Early Modern Asia" (cit. n. 37), p. 147.

But above all, a specific point of confusion lies in the actual processes of Chinese niter-making. Unlike most saltpeterers abroad who went door to door to collect nitrous earth, the Chinese (at least those in Hebei) had access to immense deposits of niter as seasonal efflorescence.[44] Thus niter workers there would likely have emphasized crude methods that bore quick results from these high-yielding soils. A common practice, for instance, was simply to dissolve the crystalline soil, skim off impurities, and crystallize the remaining solution by boiling.[45] The process indeed evoked salt-making, and the resemblance was noticed not just by the Korean observers but by their Chinese informants: when Chŏng Tuwŏn asked the locals about their method of processing niter efflorescence, they replied: it is "just like salt-making."[46]

This shows that the enterprise of translating Chinese niter-making was a precarious one, even when conducted under favorable circumstances: Koreans had the opportunity to travel, directly observe, and test Chinese practices—even with the help of willing Ming practitioners; yet the court's hunt for an exotic, "innovative" solution led nowhere.

AN ARTISANAL EXPERIMENT: SALVAGING OCEAN NITER

The Koreans were not alone in their hunt for ocean niter. On the opposite end of Eurasia, the notion of making niter out of saltwater also fascinated a "chymist" of the Hartlib circle—Frederick Clodius (1629–1702)—who experimented with it in his laboratory. Other natural philosophers in England were similarly engaged with niter-making at the time: in particular, some Londoners

---

[44] Yao Kuan described the emergence of natural niter as early as the twelfth century: "during the winter months, saltpeter springs up naturally from the earth (*zi di zhong yongqi* 自地中湧起), and that which forms penetrating bright crystals (*tongtou guangying* 通透光瑩) is called saltpeter flower (*shuanghua* 霜花)." Five centuries later this was acknowledged as well by the encyclopedist Song Yingxing 宋應星 (1587–1666), who noted the "formation of saltpeter crusts on soil"; and the mathematician Fang Zhongtong 方中通 (1634–1698), who specified that "saltpetre produced in Henan and Shandong came into existence naturally on flat ground." For Yao's observation Yao, *Xixi congyu* (cit. n. 2). On Song and Fang see, respectively, Song Yingxing, *Chinese Technology in the Seventeenth Century: T'ien-kung k'ai-wu*, trans. E-tu Zen Sun and Shiou-chuan Sun (University Park: Pennsylvania State Univ. Press, 1966), p. 269; and Fang Yizhi 方以智, *Wuli xiaoshi* 物理小識 (*Preliminary Records of the Principles of Things*) (1643; rpt., Taipei: Taiwan Shangwu yinshuguan, 1978), p. 176.

[45] All Chinese texts on niter-making to date describe this basic technique of dissolving the crystalline soil—whether as ground efflorescence or collected from walls and outhouses (*qing ce tu* 牆廁土)—and purifying it. See, e.g., the compilation of evidence in Joseph Needham *et al.*, *Science and Civilisation in China*, 5 vols., Vol. 5: *Chemistry and Chemical Technology*, Pt. 7: *Military Technology: The Gunpowder Epic* (Cambridge: Cambridge Univ. Press, 1986), pp. 99–106. There was sometimes an intermediary step of percolation—as in Europe, Korea, and Japan—whereby the soil was lixiviated through "large brick tanks, with matting used as the filter." I argue that this is what the sources describe as *linchong* (淋沖) or *linzhi* (淋汁). See *ibid.*, Vol. 5, Pt. 4: *Spagyrical Discovery and Invention: Apparatus, Theories, and Gifts* (Cambridge: Cambridge Univ. Press, 1980), pp. 192–193; and Yao, *Xixi congyu*, esp. pp. 110–112: "是河北商城及懷界沿河人家刮滷, 淋沖所就 . . . 掃取以水淋汁後乃煎煉而成." But this is not an indication that the Chinese used niter-beds. Needham—and more recently Roger Greatrex—argued that the Chinese used niter-bedding on the basis of two sources: a Tang alchemical text quoted by Yao Kuan that only mentions—and does not describe—a supposed "method of saltpeter from bird stage" (*niaochang xiaoshi fa* 鳥場消石法); and Fang Yizhi's suggestion that "saltpeter can be extracted from soil that was long corrupted by urine." These do not offer sufficient evidence. Instead, both Yao and Fang describe clearly, in these same texts, that Chinese saltpeterers processed either ground efflorescence or nitrous earth from walls in the manner outlined above, rather than using niter-bedding. See Roger Greatrex, "The Illegal Trade in Saltpetre in Southern China in the Eighteenth and Early Nineteenth Centuries," in *Southwest China in a Regional and Global Perspective (c. 1600–1911)*, ed. Ulrich Theobald and Jin Cao (Leiden: Brill, 2018), pp. 349–378; Yao, *Xixi congyu*, pp. 110–112; and Fang, *Wuli xiaoshi*, p. 176. I agree with Greatrex, however, that saltpeter in Sichuan was probably made from cave deposits: Greatrex, "Illegal Trade in Saltpetre in Southern China in the Eighteenth and Early Nineteenth Centuries," p. 363. See also Peter Lorge, "Confucian Statecraft and the Production of Saltpeter and Sulfur in Song Dynasty China," in *Science and Confucian Statecraft in East Asia*, ed. Francesca Bray and Jongtae Lim (Leiden: Brill, 2019), pp. 31–44.

[46] Chŏng, *Choch'ŏn ki chido* (cit. n. 2), pp. 117–202: "臣問其煮法, 則如我國之煮鹽焉." On the precarity of observation see Lee Jung, "Chosŏn hugi kisul chisik ŭi siryongsŏng: cheji kwallyŏn chisik ŭl t'onghae pon sirhak 조선후기 기술지식의 실용성: 제지 관련 지식을 통해 본 실학 ("The Practicalities of Late Chosŏn Technical Knowledge: Practical Studies on Papermaking"), *Han'guk kwahak sahak hakhoeji*, 2020, 42(1):125–160.

led a project for close to a decade (1655–1662), trying and testing different methods of cooking up ocean niter. Eventually, these scholars had to accept failure, as seawater just will not yield saltpeter. And with the benefit of hindsight, the alchemist George Starkey (1628–1665) would quip that it was all "a ridiculous thing, it [seawater] being a contraire nature [to saltpeter]."[47]

In Korea, too, the search for oceanic saltpeter would peter out by the 1630s. At first, however, rather than dismissing the idea entirely, local practitioners "salvaged" it by seizing on the ambiguous nature of the purported Chinese method.[48] One artisan took an experimental approach and argued that, rather than seawater, the soil in coastal regions was key to the Chinese success.

In 1595 a soldier-artisan named Im Mong 林夢 reported a workaround to the problem of ocean niter. Residing in the sea-facing county of Sŏch'ŏn 舒川, Im proposed a new resource frontier that he called "ocean soil" (*haet'o* 海土).[49] He meant not beach sand but, instead, soils collected from the salt farms of the coastline where "humans and horses had frequently trodden."[50] To be sure, his method was not the innovation that some celebrated it as: while details are elusive, it does not seem to have been fundamentally different from existing methods based on nitrous soil.[51] Nonetheless, Im was clever enough to package it in a way that elicited state interest (already piqued by ocean niter): after testing his samples in the fire, officials reported success and raised his rank considerably.[52]

The "ocean soil" method never spread far. Still, Im's investigations are noteworthy because they subtly changed the Korean discourse on ocean niter. As we have seen, until this point the court was beholden to a strict definition of the Chinese method as deriving niter directly from salt water. However, the artisan expressed obliquely that perhaps the Chinese secret to niter abundance was not so much about boiling seawater as about harnessing the soils from coastal regions. And in rewarding Im for his finding, the court acknowledged this: the officials adjusted their own terminology, retroactively characterizing their search for ocean niter as one that was not exclusively about salt water.[53]

Underpinning this subtle change were the hands-on investigations of the Korean saltpeterer, who approached the task of probing nature by way of "experiment" (*sihŏm* 試驗). Albeit terse, the sources describe Im's epistemology as "producing various plans of action and experimenting to attain efficacy."[54] In concrete terms, to "experiment" here meant to juxtapose different sample groups.

---

[47] William R. Newman and Lawrence Principe, *Alchemy Tried in the Fire: Starkey, Boyle, and the Fate of Helmontian Chymistry* (Chicago: Univ. Chicago Press, 2002), p. 254.

[48] I borrow the concept of salvaging recipes from Elaine Leong, *Recipes and Everyday Knowledge* (Chicago: Univ. Chicago Press, 2018), pp. 113–118.

[49] *Sŏnjo sillok* (cit. n. 22), 1595/5/25. Im was a "support taxpayer" (*kunbo* 軍保) for the Military Training Agency, which meant that he supplied provisions for a soldier and, in time of need, could himself be conscripted. His background was likely artisanal, given other cases of support taxpayers at the agency who served simultaneously as musketeers and saltpeterers. See *Hun'guk tŭngnok* 訓局謄錄 (*Records of the Military Training Agency*) (1615–1881), JSG Collection, K2-3398-3401, 1691/9/30.

[50] *Sŏnjo sillok*, 1595/5/25: "所取海土, 必於鹽場人馬踏行處取之."

[51] For one thing, the collection of nitrous earth from human- and animal-trafficked areas was a common practice. Also, by taking soils potentially drenched in saltwater, Im ended up producing solutions that were "excessively salty" (*t'aeham* 太鹹), which could make the saltpeter precipitations less pure. *SI*, 1669/1/6.

[52] *Sŏnjo sillok* (cit. n. 22), 1595/5/25, 1595/6/25.

[53] *Ibid*., 1595/5/25. Even after Im was long forgotten, Korean authorities continued to use a flexible concept of ocean niter: in 1669, when Korean practitioners had already moved past ocean niter, the court looked back and discussed both salt water and ocean soil as variants of a single, fundamental method of working with the ocean. What had changed by 1669, however, was that the reference to ocean soil was not what Im had originally meant: soils from salt farms. Rather, it meant specifically the crystalline soil collected from China's "saline marshes" (*ch'ŏngno* 斥鹵), which the Koreans had "failed" to use productively. This is the result of espionage in 1630 and the ensuing experiments, described in the next section. See *SI*, 1669/1/6.

[54] *Sŏnjo sillok*, 1595/5/25: "凡焰硝煮取之事, 多般出計, 試驗得效."

As the official report shows, Im submitted to the court one batch of saltpeter made entirely from ocean soil and another made from one part ocean soil and two parts regular nitrous earth. This suggests that the saltpeterer consciously designed and implemented two kinds of test groups by varying their contents. To be sure, what we might today call a "control group" (a batch of saltpeter made from entirely regular nitrous earth) was not present. But we can allow that such a sample was assumed or, indeed, already at the court's disposal for comparison.[55]

This is one form of experimentalism where empirical testing was employed repeatedly and in an orchestrated fashion to investigate the natural world.[56] In fact, the Korean notion of *sihŏm* even emphasized the epistemic role of demonstrations and sensory experience in verifying new knowledge. For example, when Im first notified the court about his method, Cho Hyonam 趙孝南—a production manager (*kamgwan* 監官) at the Military Training Agency (*Hullyŏn togam* 訓鍊都監)—took him to a nitrary to observe it. Together, Im and Cho prepared the aforementioned soil samples to be submitted to court. Even after the samples were tested, however, a second trial was in order, carried out by another team of artisans under a different supervisor. The purpose of this was to have Im yet again "boil and obtain saltpeter before their eyes, and carefully test what is true and false." But this time a more specific mission was given: to verify exactly how much and what kind of resources went into production and the resulting yield.[57]

These experiments drew from the long-standing artisanal tradition of prototyping (*kyŏnyang*). In the typical development cycle of a Korean artifact, artisans prepared prototypes of their craft design, and these were then presented to the court for approval before being distributed for replication at other workshops.[58] As an extension of these practices, Im's use of soil samples to demonstrate the efficacy of his method was an exercise in prototyping. Also, as this activity typically generated not just material results but also a piece of knowledge or theory about the material world, so did Im's. Rather than floating about in the vast ocean, he reasoned, saltpeter had a specific origin: it grew in soils that mingled constantly with living things—as in places where "humans and horses had frequently trodden."[59]

PROTOTYPING NITER

It was in the spirit of *sihŏm* that Korean saltpeterers scrutinized niter efflorescence in 1631. Central to this process were the aforementioned manager Sŏng Kŭn and the artisans he led at the arsenal's Special Manufactory (*Pyŏljoch'ŏng* 別造廳). The manufactory was an experimental workshop, set up only a few weeks after the return of the Korean mission. There, between 1631 and 1635, Sŏng and his men set out to replicate the conditions that would induce saltpeter to spring forth in the form of a white, crystalline soil like that found in Hebei.[60]

---

[55] *Ibid.*: "得海土所煮焰硝一斤, 鹹土二分, 海土一分, 合煮焰硝三斤以來. 合劑試放, 精猛可用, 故兩色藥各封進."

[56] Ursula Klein has demonstrated at least three different styles of experimentalism for early modern Europe—not just natural philosophy, but also technological inquiry and experimental history (*historia experimentalis*). Compared to experimental philosophers in early modern Europe, the Korean practitioners seem "reticent about contextualizing their undertaking within theoretical frameworks": Leong, *Recipes and Everyday Knowledge* (cit. n. 48), p. 122. But in this they are similar to experimenters in the other two styles. See Ursula Klein, "Experiments at the Intersection of Experimental History, Technological Inquiry, and Conceptually Driven Analysis: A Case Study from Early Nineteenth-Century France," *Perspectives on Science*, 2005, *13*:1–48.

[57] *Sŏnjo sillok* (cit. n. 22), 1595/5/25. The concern with input and output is also seen in other military workshops, where artisans and managers cooperated in the preparation of prototypes; this process often led to the writing of "formulae" (*sik* 式)—recipes of craft knowledge that ranged from simple lists of ingredients to full-fledged technological manuals. See Kang, "Crafting Knowledge" (cit. n. 8), pp. 174–185.

[58] Kang, "Crafting Knowledge," pp. 120–154.

[59] *Sŏnjo sillok* (cit. n. 22), 1595/5/25.

[60] On the multiyear nature of this project see *SI*, 1634/12/14.

The sources do not elaborate on Sŏng's investigations, other than that he "personally experimented (*sihŏm*) by advancing his own thoughts."[61] Yet we know that the soil sample presumably handed to him was called a prototype (*kyŏnyang*), which hints that it stood as the desired outcome that the saltpeterers strove to imitate through experiment.[62]

At any rate, the results tell their own tale. In 1635, when Sŏng and his coauthors published Korea's first-ever treatise on niter—*Vernacular Renditions on the New Method of Saltpeter-Making* (*Sinjŏn chach'wi yŏmch'obang ŏnhae* 新傳煮取焰硝方諺解), they explained the fifteen essential steps required for making saltpeter, from soil collection and lixiviation to fractional crystallization (see Table 1).[63] What concerns us here are the first four, which describe how to make and remake niter efflorescence in a multiyear cycle of niter-bedding:

> Soil collection: Scrape carefully with a bent shovel only the surface of the earth in old houses, especially from under the kitchen floor, the wooden flooring, the walls, and the *ondol* stones (floor-heating stones). If when you lick and taste with the tongue it tastes salty, sour, sweet, or spicy, then this is good; collect the soil in this way.
>
> Incorporation: Also take human urine, ashes from under kitchen cauldrons, and miscellaneous ashes, and mix these with the abovementioned earth. Incorporate by using shovels to turn them over many times and make a heap in one place so as to avoid rain. It is even better if stacked under roofed houses.
>
> Fermenting white: Also take horse dung, dry it under sunlight, and cover with it the top of the heaps of soil. Torch [the dried dung] with flame so that its essence is steamed and seeped thoroughly [into the heaps]. After this, a white moss will form naturally from the fermentation of hot moisture. Use after four to five months, but the longer you wait the better.
>
> Reusing residual earth: After using this earth, retrieve the residual soils. Then, take human urine, horse dung, and the various ashes—as well as fresh fireclay—and incorporate these together with the residual soils to make a watery mixture. If you wish, use these to make walls and fences [within the nitrary] to avoid rain and use it after waiting three years. Its quality becomes better than newly collected earth.[64]

According to Sŏng's prescriptions, nitrous earth was first to be collected from traditional sources after carefully "prospecting" the soil—tasting it with the tongue. This earth was then enriched by mixing in other nitrogenous wastes such as human urine, horse dung, and various ashes. After that, the resulting heaps of soil were "steamed" and left to "ferment" for months, if not years, which led to the growth of what Sŏng called "white moss" (*hŭin itki* 흰 잇기). At this point, the soil was ready to be used (lixiviated and crystallized), but the residual earth was to undergo another cycle of enrichment with urine, dung, and ashes in order to regenerate for three years.

I interpret the preliminary product of this technique—white moss—as the Korean recreation of Chinese niter efflorescence. As clarified in a 1561 manuscript by a German saltpeterer in England, the practice of niter-bedding with urine, horse dung, and "lye" (ashes of plaster or oyster shells) produced saltpeter that "will hang upon the walls lyke snowe." This is also confirmed by the experiments of A. R. Williams and Haileigh Robertson (with the Medieval

---

61 Sŏng, *Sinjŏn chach'wi* (cit. n. 26), pp. 1b–2a: "제의 의ᄉᆞ로ᄡᅥ 닐위여 ᄉᆞᄉᆞ로 시험ᄒᆞ고."

62 We also know, retrospectively, that these Korean investigators organized themselves in groups of ten—three artisans and seven assistants—and worked with a wide array of equipment—e.g., vats, cauldrons, settling tubs, sieves, ladles, gutters, and reduction pans. *Ibid.*, pp. 17a–20b. See also Cho, *Sokchamnok* (cit. n. 5), Vol. 7, p. 78a.

63 Sŏng, *Sinjŏn chach'wi*.

64 *Ibid.*, pp. 2b–4b.

Table 1. Overview of Korean Niter-Making, 1635

Title	Summary
Soil collection	Scrape only the surface of the earth in old houses, especially from under the kitchen floor, the wooden flooring, walls, and floor heating stones. Use earth that tastes salty, sour, sweet, or spicy.
Incorporation	Mix human urine, ashes from under kitchen cauldrons, and miscellaneous ashes with the collected earth. Use shovels to turn them over many times and make a heap. Avoid rain and keep under roofs.
Fermenting white	Cover the heap with dried horse dung and steam with heat. A white moss will form naturally. Use after four to five months, but the longer you wait the better.
Reusing residual earth	Keep the residual soils and incorporate them with urine, horse dung, and the various ashes—as well as fresh fireclay—to form a watery mixture. Use this to make walls and fences; avoid rain and use [saltpeter growing from these] after three years. The quality becomes better than newly collected earth.
Ash-making	Use *suaeda glauca* and sorghum stalks for ash. They can be stored near the ocean for 40 days and dried for use. Or take ashes from under kitchen caldrons and ashes of dried horse dung, oak, and mugwort; mix them in with water; and ferment the solution on *ondol* (floor heating stones) for 5 to 6 days before use.
Lixiviation	Lay out 2 *mal* of horse dung in the settling tubs and then cover that with 10 *mal* of nitrous earth. Layer this again with *suaeda glauca* and other miscellaneous ashes—4 *mal* each, blended together. Then put 20 *mal* of nitrous earth. Pour water over the tubs and obtain a leachate. Once the tubs are drained, fill them with water for a second wash and use this new "water" for the next time.
First boiling	Reduce the solution to 1/3 and know when to stop the fire by using a brass ladle: when scooping with this ladle the liquid is viscous and sticks together in two strands, stop the fire. If the solution is over-reduced, refresh it by adding more leachate. If not done properly in this manner, too much salt—and not enough saltpeter—will crystallize in the second boiling. Around 4 p.m. transfer the solution to other caldrons to clarify. Around 1 a.m., distribute this solution into different caldrons and boil again until it becomes—when tried on brass reduction pans—the shape of butterfly wings. Add more leachate, boil, and skim off the scum. Stop the fire if it hardens from the inside when tested on the ladle. Use a horsehair ladle to remove salt from the bottom of the cauldron and other frosty crystals floating on the surface. Let the crude saltpeter crystallize on the reduction pans.
Second boiling	Dissolve the crude saltpeter in water and boil. Add glue so that the impurities stick together and can easily be removed. Bring to a vigorous boil once or twice more and skim off the unnecessary crystals. Stop the fire if the solution crystallizes in shapes like icicles when tested with a ladle.
Third boiling	Repeat the second boiling process if good quality saltpeter was not obtained.

Source: Sŏng, *Sinjŏn chach'wi*, pp. 2b–19b.

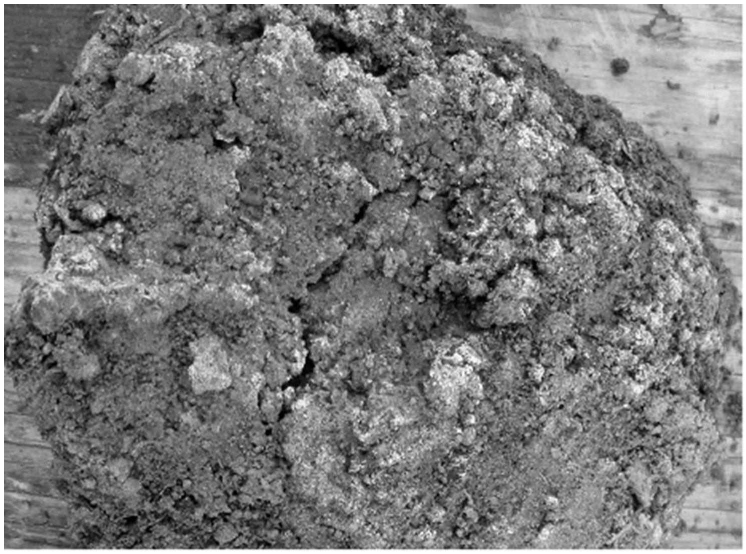


Figure 2. Crystalline soil made by reworking German-English methods of niter-bedding by the Medieval Gunpowder Research Group. Image courtesy of Ruth Brown.

Gunpowder Research Group), who reworked the German-English recipe in their laboratories, recording that a "white coating" and "nitrous earth crystals" did appear (see Figure 2).[65]

The similarities between the Korean and European practices are striking, and they suggest an external vector of influence: the exchange between Chŏng Hyogil and the Portuguese. There are two compelling bits of evidence for this, though they are circumstantial.[66] First, the practice of niter-bedding with the particular combination of human urine, horse dung, and ashes is unprecedented in East Asia: the concept of niter-beds was neither practiced by nor relevant to the Chinese saltpeterers; and in Japan only the saltpeterers of Gokayama employed it—and they used silkworm excreta, not urine and horse dung. Moreover, the resemblance is not simply in the mixture of these materials but in the details of how the soils should be mixed, blended, and kept away from rain—and, remarkably, the order of the steps (e.g., the explanation of soil recycling before lixiviation). Second, the recycling of residual soils to make saltpeter-generating walls is another distinctively European practice. The aforementioned manuscript from 1561 instructed that newly made bricks should be treated with lye and mixed with nitrous earth to make walls. The technique of using recycled earth goes back in Germany to as early as 1405. But in Korea it was not suggested until 1634, when the manufactory expanded its operations by building new tile-roofed workshops. The facts that this predates the publication of Sŏng's manual by just one year and that the prescription in the manual was to "ferment" for three years are further indications that the technique likely originated from Europe.[67]

---

[65] Williams, "Production of Saltpetre in the Middle Ages" (cit. n. 14), p. 130. Williams noted that the white coating was "not due to nitrates, or any salts, but a bacterial growth of some species" (*ibid*., p. 128). Robertson further clarified that "in nitrous earth crystals can be visible in the mud, although (to use modern terminology) these are generally calcium and other nitrates rather than saltpetre itself." Robertson, "Reworking Seventeenth-Century Saltpetre" (cit. n. 14), p. 150.

[66] On the exchange of information between Chŏng and Rodrigues see note 31, above.

[67] On the absence of niter-bedding in China see note 45, above. Japanese practices have been meticulously researched and described in Itagaki, "Kagahan no kayaku" (cit. n. 4), pp. 112–119; and Itagaki, "Gokayama no Ensho" (cit. n. 17), pp. 31–42. On residual soil see Sŏng, *Sinjŏn chach'wi* (cit. n. 26), pp. 2b–19b. Cf. Williams, "Production of Saltpetre in the Middle Ages" (cit. n. 14), pp. 129–130. See also *SI*, 1634/12/14: "若造連楸瓦家數十間, 則可無每年蓋覆之憂, 而用後滓土, 亦可推移以用云."

This seems to support the view that niter knowledge was a "fluid thing" after all, one that could prompt the emergence of similar methods at the opposite ends of Eurasia.[68] I argue, however, that while the Korean–Portuguese encounter may have featured a significant transmission of knowledge, Chosŏn's theory of fermentation developed through its own vernacular pathways.

Before the arrival of the Chinese efflorescence sample, Korean saltpeterers were already inclined to think about niter as something that is "produced" (*san* 産) in the soil. For example, Im's theory—that niter (re)generates through human and animal contact—was an elaboration on this thinking. Other saltpeterers, too, shared this view—that "nitrous earth is not made in the fields and mountains or other vast, open spaces (*konggwangch'ŏ* 空曠處), but in soils from aged houses that humans and horses have trampled on."[69] With the arrival of the soil sample from China, it lay close at hand that the next generation of Korean artisans should attempt "growing" their own niter efflorescence. Specifically, we can surmise that the vernacular notion of fermentation led the practitioners to identify and mimic the process of niter generation.

Returning to Sŏng's manual, which was written in both literary Sinitic and vernacular Korean, the notion of fermentation appears twice: first as "fermenting white" (*chŭngbaek* 蒸白) and then as "the method of fermenting (*ttŭiwŏ* 띄워) to make hazy (*puhŭige* 부희게)."[70] The reference to Korean culinary practices here is unmistakable—and, in particular, the vernacular word "*ttŭiwŏ*." This word evokes the preparation of a food source called *meju* (K. 메주; Ch. 末醬). Every winter, a chief task in the Korean kitchen was to make bricks out of cooked soybeans and "steam" (*hunjŭng* 薰蒸) them under a blanket of rice stalks to ferment. After this, owing to bacterial growth, the bricks acquired a white coating on their surface (see Figure 3), which was an indication that they could then be processed into a number of condiments, including soybean paste and soy sauce. In processing *meju* there was a second fermentation method, whereby the white bricks were pulverized, incorporated with brine, among other ingredients, and "steamed" again. This time they were preserved in a tightly sealed crock, to be placed deep inside a heap of horse dung, which traps the heat and acts as a natural "fermenter."[71]

---

[68] In fact, one may even speculate that the notion of fermenting saltpeter—central to both Korean and European practices—was transferred whole, not homegrown. In western Europe, Robertson argues, the conception that niter may be "grown, fermented, and farmed" arose from a specifically Paracelsian theory of nature: saltpeter, the theory went, was a universal salt that made and maintained all life—i.e., manifesting itself in the vegetal, animal, and mineral realms; and as such, it could be "begot in the Earth by a kind of fermentation." Robertson, "Reworking Seventeenth-Century Saltpetre" (cit. n. 14), p. 149. See also Allen G. Debus, "The Paracelsian Aerial Niter," *Isis*, 1964, 55:43–61; and Anna Marie Roos, *The Salt of the Earth: Natural Philosophy, Medicine, and Chymistry in England, 1650–1750* (Leiden: Brill, 2007), esp. pp. 23–25. It bears remembering, however, that the notion of fermentation was commonplace, found in European alchemical traditions as well as in kitchens and breweries across various cultures and regions. For a discussion of fermentation in early modern alchemy and chemistry see Bruce Moran, *Distilling Knowledge: Alchemy, Chemistry, and the Scientific Revolution* (Cambridge, Mass.: Harvard Univ. Press, 2009), esp. pp. 22, 91–95, 116–118, 129, 139; and Debus, *The Chemical Philosophy: Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries* (1977; Mineola, N.Y.: Dover, 2002), esp. pp. 343–344, 355, 370, 524. I thank Justin Niermeier-Dohoney for his suggestions here.

[69] *Kwanghaegun ilgi* 光海君日記 (*Daily Records of Prince Kwanghae*), in *CWS*, 1615/8/17: "而劑造惟在於鹹土, 鹹土非山野空曠處所産, 必敢久遠家舍人物踐踏之土可用."

[70] Sŏng, *Sinjŏn chach'wi* (cit. n. 26), pp. 2b–4b.

[71] On the historical methods and recipes for making *meju* and its derivative sauces see Choi Young-Jin *et al.*, "17 segi ijŏn changnyu e taehan munhŏn chŏk koch'al" 17세기 이전 장류에 대한 문헌적 고찰 ("Review of Historical Literature on Korean Sauces before the Seventeenth Century"), *Han'guk sikp'um chori kwahakhoe chi*, 2007, 23(1):107–123. On the use of horse dung—and its alternative, fertilizer manure (*tuŏm* 두엄)—see *ibid.*, pp. 114–118. The appearance of white coating on *meju* bricks was due to the growth of *Aspergillus oryzae* and/or *Bacillus subtilis*. See Hong Seung-Beom, Kim Dae-Ho, and Robert A. Samson, "Aspergillus Associated with Meju, a Fermented Soybean Starting Material for Traditional Soy Sauce and Soybean Paste in Korea," *Mycobiology*, 2015, 43:218–224.

Figure 3. Fermentation of *meju*. Lumps of soybeans are left to dry and ferment on rice straws to acquire a white coating. Image courtesy of Korea Educational Broadcasting System.

Korean cookery thus likely inspired Sŏng's niter-bedding techniques. Not only did *meju*-making and niter-making both take place in the winter, but the two processes also shared striking resemblances in content: a similar array of tools (e.g., cauldrons, ladles, earthenware), the notion of steaming to induce the white efflorescence, and, finally, the use of horse dung for fermentation.[72]

THE UNFINISHED EXPERIMENT

The *Vernacular Renditions* presents a rich tapestry of niter-knowledge, both vernacular and global, some of which was tested over centuries, some that had emerged more recently through the experiments in the 1630s, and still more that had yet to be fully vetted but was nevertheless included as an impetus to future study. And what is indeed generative about the handbook is this last part: its open-endedness.

Reading the *Vernacular Renditions*, one feels as though it was never meant to be a definitive statement—a master's last say—on the subject. This was in part because its author-practitioners knew at heart the ineffability of certain practices: a saltpeterer, for instance, needed trained senses to prospect for soil that was not too salty (to increase the purity of the saltpeter) and to test—using ladles and visual cues—the viscosity of the solution before crystallization (to prevent overcooking). Tellingly, the book also admitted that the procedures outlined were somewhat artificially "divided into 15 parts" and "put concisely."[73]

More explicitly, however, *Vernacular Renditions* was written with an eye to continual revision—as an open-ended document, if you will, that was meant to grow with the passing years.[74]

---

[72] On the seasonal rhythm of saltpeter-making see *Kojong sillok* 高宗實錄 (*Veritable Records of Kojong's Reign*), in *CWS*, 1867/1/16: "製藥自有節候, 非立冬後, 雨水前, 不能成硝." The military workshops also made *meju* annually: *Ŏyŏngch'ŏng singnye* 御營廳式例 (*Precedents at the Royal Division*) (1868), JSG Collection, K2-3355, section titled "Chiji susi sangha" 紙地隨時上下 (unpaginated).

[73] Sŏng, *Sinjŏn chach'wi* (cit. n. 26), pp. 1b–2a.

[74] *Ibid.*, pp. 17a–20b: "비록 ᄒᆞᆫ 가마로ᄡᅥ 혜알일 ᄯᅵ라도 열 ᄲᅩᆯ을 달히면 반ᄃᆞ시 一일千쳔六뉵七칠白빅斤근에 ᄂᆞ리디 안일 ᄭᅥ시니어늘 이젯 사ᄅᆞᆷ이 이 묘리ᄅᆞᆯ 아디 몯ᄒᆞ고." Another aspect of the book that shows its use as a practitioner's manual is that it provides only a

The first step toward revision is the admission of failure, and Korean saltpeterers were not shy in embracing their own. In a final section, entitled "General Formula" (*ch'ongsik* 摠式), Sŏng wrote that despite his best calculations—that is, "even when measuring carefully the yield from one cauldron"—the input and output of production did not adhere perfectly to his prescribed formula. This inexactness, he thought, was due to the "people of this age not knowing its secrets fully." But rather than suggesting that his predecessors in antiquity would have fared better, Sŏng meant that future practitioners like him would hold the key to unlocking these "secrets." As the book's preface opens, "In order to add or subtract and make [this book] more appropriate, we wait again for other knowledgeable persons."[75]

Korean experiments with saltpeter went on until the nineteenth century, well beyond the scope of this essay.[76] For our purposes, however, it was the *Vernacular Renditions* that set the tone for future investigations: Sŏng's book began a new way of practicing niter knowledge that mobilized the vernacular, *han'gŭl* script alongside literary Sinitic; it also founded a community of reader-practitioners that included the artisans and officers.[77]

In opening the handbook, so conspicuously titled *Vernacular Renditions*, the reader meets a distinctive linguistic register that employs both cosmopolitan and vernacular languages. There are two elements: the authoritative literary Sinitic, annotated with matching pronunciations in Korean for every character; and an auxiliary vernacular Korean that paraphrased and at times more loosely translated the former.[78] Known as *ŏnhae* (諺解), this linguistic practice served as a technology for inscribing novel knowledge that emerged from the shopfloor. And as shown above with the notion of *ttŭiwŏ* (fermentation), this register may well have increased the clarity and reproducibility of the knowledge at hand: *ŏnhae* combines the merits of two languages by alternating between literary Sinitic—which is widely legible yet potentially ambiguous—and the vernacular—which is immediate, easy to understand, and closer to the practitioners' tongue (see Figure 4). Socially, as well, *ŏnhae* was more accessible. This linguistic practice was not limited to the *yangban* (aristocratic) scholars who used it as an exegetical tool to interpret the Confucian classics. It also allowed for the participation of nonelite peoples in Korean society—from slaves to commoners

---

succinct introduction—relegated to a separate publissher's note at the very end—and begins immediately with the first of the fifteen steps in niter-making. The publisher's note is also the only part rendered in literary Sinitic only. *Ibid.*, pp. 1a, 21a–22b.

[75] *Ibid.*, pp. 1b–2a: "더으며 덜어 맛당케 ᄒᆞ기ᄂᆞᆫ 다시 아ᄂᆞᆫ 이ᄅᆞᆯ 기도로ᄂᆞ니다."

[76] The relatively rapid spread of the *Vernacular Renditions* was already apparent in the 1630s: because Sŏng's methods were developed through the arsenal and its network of provincial workshops, it was already well known among the saltpeterers. *Vernacular Renditions* was reprinted in 1685 and again in 1796, and despite the appearance of a competing text it remained a classic: in 1798 an abridged version was circulated as part of a new compilation, and as late as 1847 the text was continually copied, corrected, and significantly altered by practitioners. For the 1685 reprint see JSG Collection, K3-310. The 1796 reprint also includes the competing niter manual—Kim Chinam's *New Method*—after Sŏng's, but the marginalia of the text in the JSG Collection indicate the use of Sŏng's book only. See Sŏng Kŭn 成根, *Sinjŏn chach'wi yŏmch'obang ŏnhae* 新傳煮取焰硝方諺解 (*Vernacular Renditions on the New Method of Saltpeter-Making*) (1635; rpt., Seoul: Pongmodang 奉謨堂, 1796), JSG Collection, K3-311. The 1798 and 1847 versions are in, respectively, Yi Sangjŏng 李象鼎, *Pyŏnghak chinam yŏnŭi* 兵學指南演義 (*Commentaries on the Guide to the Military Arts*), in *Kunsa munhŏnjip* 군사문헌집, Vols. 17–19 (1798; rpt., Seoul: Kukpangbu Kunsa P'yŏnch'an Yŏn'guso, 1995–1997), Vol. 18, pp. 68–69; and *Ch'ongwiyŏng sarye* 總衛營事例 (*Precedents at the General Guards Division*) (1847), JSG Collection, K2-3378, section titled "Chapsik" 雜式 (unpaginated).

[77] On vernacular science see Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: Univ. Chicago Press, 2004); Helen Tilley, "Global Histories, Vernacular Science, and African Genealogies; or, Is the History of Science Ready for the World?" *Isis*, 2010, *101*:110–119; and Eric Moses Gurevitch, "The Uses of Useful Knowledge and the Languages of Vernacular Science: Perspectives from Southwest India," *History of Science*, 2020, 59:256–286. See also Eugenia Lean, *Vernacular Industrialism in China: Local Innovation and Translated Technologies in the Making of a Cosmetics Empire, 1900–1940* (New York: Columbia Univ. Press, 2020).

[78] Si Nae Park aptly describes these as "text-as-vocalized" and "text-as-paraphrased," respectively. See Si Nae Park, "The Sound of Learning the Confucian Classics in Chosŏn Korea," *Harvard Journal of Asiatic Studies*, 2019, 79(1–2):131–187.

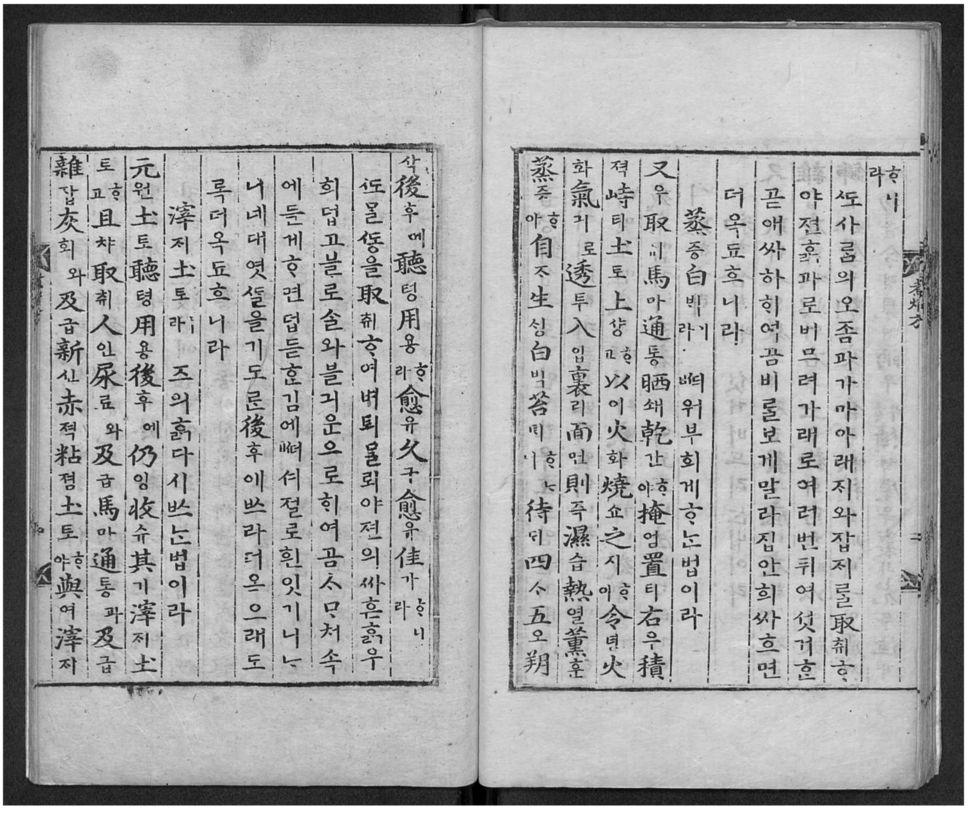


Figure 4. The fermentation process in *Vernacular Renditions*, given in the two linguistic registers in order, from right to left. Source: Sŏng Kŭn 成根, *Sinjŏn chach'wi yŏmch'obangŏnhae* 新傳煮取焰硝方諺解 (*Vernacular Renditions on the New Method of Saltpeter-Making*), in *Hwap'osik ŏnhae* 火砲式諺解 (*Vernacular Annotations on the Firearms Manual*), ed. Yi Sŏ 李曙 (1635; rpt., 1685), JSG Collection, K3-310, pp. 3b–4a.

and the technical specialists (known as "middle people" 中人)—thereby animating a form of practical literacy that opened its doors to artisans and practitioners.[79]

We know that during the course of the seventeenth century such a community of reader-practitioners did emerge. The book was read by military men of all ranks, from generals down to rank-and-file soldiers. From the beginning, the army's top brass was involved in the compilation of the *Vernacular Renditions*: General Yi Sŏ—whom Sŏng Kŭn served—was a coauthor, and he attached it to the end of his own *Vernacular Edition of the Formulae on Firearms* (*Hwap'osik ŏnhae* 火砲式諺解) (1635). Thanks in part to this affiliation, Sŏng's work was read, recited, and memorized by low-ranking officers and ordinary soldiers alike. Those in the artillery regiment were the primary audience: as part of their monthly drill, the vernacularized texts were read aloud and "expounded," and thus soldiers (cannoneers) with better mastery than others could ascend to the positions of tutor

[79] As early as 1445, there were Korean slaves who were literate and proficient at calculation; they worked as secretaries in the Ordnance Office. See *Sejong sillok* (cit. n. 3), 1445/9/27. On vernacular Korean texts and literacy see Kin Bunkyō, *Literary Sinitic and East Asia: A Cultural Sphere of Vernacular Reading*, ed. Ross King, trans. King *et al.* (Leiden: Brill, 2021).

(*kyosa* 教師), head tutor (*top'aedu* 都牌頭), and clerk (*sŏjaji* 書字的)—if not into the ranks of the officer corps proper.[80]

These military men were "practitioners" in a broad sense: most soldiers operated machines that required a connoisseurship of gunpowder, and their superiors needed to be proficient enough to test them. But in the narrow sense, as well, they were craftspeople in their own right: as indicated by soldiers Im and Pak and officers Sŏng and Chŏng, these men served simultaneously as workers and managers of artisanal workshops. The Korean nitraries were in fact a crucial aspect of this "skilling" of the military: after the seventeenth century, the capital armies of Seoul possessed their own in-house nitraries, and soldiers served there for decades, becoming "master artisans of saltpeter" (*yŏmch'o p'yŏnsu* 焰硝邊首) and winning manumission, as they were often of slave status.[81] Moreover, these saltpeterers became cross-affiliated with the artillery regiment, which had always welcomed—and in fact recruited from—other artisan groups, such as casters (*chujang* 鑄匠), coppersmiths (*tongjang* 銅匠), brasswarers (*yugijang* 鍮器匠), and blacksmiths (*yajang* 冶匠).[82] And there, just like other cannoneers and petty officers, the master artisans of saltpeter studied and amended the texts that grew from the very foundation of their practices.[83]

CONCLUSION

During the seventeenth century, saltpeter was a significant object of natural knowledge across the early modern world. From experimental philosophers in England to workshop managers in Korea, practitioners around the globe set out to investigate niter, understand its place in nature, and boost production in their respective industries. This early modern convergence had little to do with the fluid circulation of knowledge and technology regarding niter. Instead, it was forged in the very moments when such movement of knowledge failed, stopped, or became highly unstable, as in the Korean efforts to replicate niter brought from China.

These frictions in the transit of knowledge were productive in their own ways. In Korea, the local saltpeterers faced first the myth of ocean niter and then the dearth of niter efflorescence. But these obstacles applied selective pressures on the Koreans to cultivate new habits of knowledge-making. First, by grappling with saltpeter and its difficult materiality, they grew more methodical in the vetting of foreign knowledge through hands-on trials. Backed by the state, this process also activated a mode of experimentalism in the governmental workshops, where artisans and officers systematically employed the vernacular practices of *sihŏm* (experiment) and *kyŏnyang* (prototyping). Finally, the resulting knowledge did not resolve all production issues or raise Korean yields to the level achieved by the Hebei saltpeterers. It had other by-products, however: *Vernacular*

---

[80] *Kŭmwiyŏng tŭngnok* 禁衛營謄錄 (*Records of the Palace Guards Division*) (1682–1883), JSG Collection, K2-3292, 1687/2/27. These recitations included not only the *Vernacular Edition of Formulae on Firearms* but also the niter-making manuals that accompanied it, notably the *Vernacular Renditions*. See *Hun'guk tŭngch'o* 訓局謄鈔 (*Copied Records of the Military Training Agency*) (1710–1834), JSG Collection, K2-3402, 1816/4. For the version that was likely used in these recitations see Yi Sŏ 李曙, ed., *Hwap'osik ŏnhae* 火砲式諺解 (*Vernacular Annotations on the Firearms Manual*) (Seoul: Government Arsenal, 1635; rpt., 1685), Ogura Bunko, Tokyo University, Japan, L174545. On recitation practices at the artillery regiments see Yi Chaejŏng 이재정, "Pyŏlp'ajin kwa Chosŏn hugi taep'o unyong" 별파진과 조선후기 대포 운용 ("Artillery Regiments and Their Use of Artillery in the Late Chosŏn Period") (M.A. thesis., Seoul National Univ., 2017), pp. 15–28.

[81] *Hun'guk tŭngnok* (cit. n. 49), 1691/9/30. On the "skilling" of the military, which led to the rise of the soldier-artisan (*kongjangdae* 工匠隊: "artisan squad") and the officer-manager (*kamdong changgyo* 監董將校), see Kang, "Crafting Knowledge" (cit. n. 8), pp. 64–119.

[82] *Hun'guk tŭngch'o* (cit. n. 80), 1816/4: "焰硝及搗藥邊首等, 本是軍摠中別破陣兼役者"; and *Kŭmwiyŏng tŭngnok* (cit. n. 80), 1687/2/27: "鑄匠及銅匠, 鍮器匠, 冶匠, 各三名, 稱以別破陣."

[83] *Hun'guk tŭngch'o*, 1816/4: "焰硝及搗藥邊首等 . . . 硝藥製造之方, 十五日內, 能誦然後, 竝與火砲式, 而使之能講爲旀 . . . 邊首旣付本色, 則講朔之法, 不可異同, 火砲式, 戎垣必備一體, 考講爲白齊 . . . 取才時 . . . 火砲式上下篇, 製藥式, 煮硝方, 戎垣必備, 各一大文."

Renditions gave rise to a community of reader-practitioners and their practices of engaging craft knowledge in two mutually reinforcing languages. Taken together, these developments show us the *modus operandi* of small-scale, localized knowers and makers who engaged the early modern world subtly but surely, by forming epistemic cultures that at once paralleled and diverged from those of more mainstream, globally engaged actors.