

GEORGIUS AGRICOLA
DE RE METALLICA

TRANSLATED FROM THE FIRST LATIN EDITION OF 1556

with

Biographical Introduction, Annotations and Appendices upon
the Development of Mining Methods, Metallurgical
Processes, Geology, Mineralogy & Mining Law
from the earliest times to the 16th Century

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Native as well as manufactured *nitrum* is mixed in vats with urine and boiled in the same caldrons; the decoction is poured into vats in which are copper wires, and, adhering to them, it hardens and becomes *chrysocolla*, which the Moors call *borax*. Formerly *nitrum* was compounded with Cyprian verdigris, and ground with Cyprian copper in Cyprian mortars, as Pliny writes. Some *chrysocolla* is made of rock-alum and sal-ammoniac.⁸

soda and potash in distinction to *nitre* for saltpetre, and later *natron* was applied solely to soda.

It is desirable to mention here two other forms of soda and potash which are frequently mentioned by Agricola. "Ashes which wool dyers use" (*cineres quo infectores lanarum utuntur*).—There is no indication in any of Agricola's works as to whether this was some special wood-ash or whether it was the calcined residues from wool washing. The "yolk" or "suint" of wool, originating from the perspiration of the animal, has long been a source of crude potash. The water, after washing the wool, is evaporated, and the residue calcined. It contains about 85% K_2CO_3 , the remainder being sodium and potassium sulphates. Another reason for assuming that it was not a wood-ash product, is that these products are separately mentioned. In either event, whether obtained from wool residues or from lixiviation of wood-ash, it would be an impure potash. In some methods of wool dyeing, a wash of soda was first given, so that it is barely possible that this substance was sodium carbonate.

"Salt made from the ashes of musk ivy" (*sal ex anthyllidis cinere factus*,—Glossary. *salakali*). This would be largely potash.

*This paragraph displays hopeless ignorance. Borax was known to Agricola and greatly used in his time; it certainly was not made from these compounds, but was imported from Central Asia. Sal-ammoniac was also known in his time, and was used like borax as a soldering agent. The reaction given by Agricola would yield free ammonia. The following historical notes on borax and sal-ammoniac may be of service.

BORAX.—The uncertainties of the ancient distinctions in salts involve borax deeply. The word *Baurach* occurs in Geber and the other early Alchemistic writings, but there is nothing to prove that it was modern borax. There cannot be the slightest doubt, however, that the material referred to by Agricola as *borax* was our borax, because of the characteristic qualities incidentally mentioned in Book VII. That he believed it was an artificial product from *nitrum* is evident enough from his usual expression "*chrysocolla* made from *nitrum*, which the Moors call *borax*." Agricola, in *De Natura Fossilium* (p. 206-7), makes the following statements, which could leave no doubt on the subject:—"Native *nitrum* is found "in the earth or on the surface. . . . It is from this variety that the Venetians make "*chrysocolla*, which I call *borax*. . . . The second variety of artificial *nitrum* is made "at the present day from the native *nitrum*, called by the Arabs *tincar*, but I call it usually "by the Greek name *chrysocolla*; it is really the Arabic *borax*. . . . This *nitrum* does not "decrepitate nor fly out of the fire; however, the native variety swells up from within." The application of the word *chrysocolla* (*chrysos*, gold; *colla*, solder) to soldering materials, and at the same time to the copper mineral, is of Greek origin. If any further proof were needed as to the substance meant by Agricola, it lies in the word *tincar*. For a long time the borax of Europe was imported from Central Asia, through Constantinople and Venice, under the name of *tincal* or *tincar*. When this trade began, we do not know; evidently before Agricola's time. The statement here of making borax from alum and sal-ammoniac is identical with the assertion of Biringuccio (ii. 9).

SAL-AMMONIAC.—The early history of this—ammonium chloride—is also under a cloud. Pliny (xxxii., 39) speaks of a *sal-hammoniacum*, and Dioscorides (v., 85) uses much the same word. Pliny describes it as from near the temple of Ammon in Egypt. None of the distinctive characteristics of sal-ammoniac are mentioned, and there is every reason to believe it was either common salt or soda. Herodotus, Strabo, and others mention common salt sent from about the same locality. The first authentic mention is in Geber, who calls it *sal-ammoniacum*, and describes a method of making, and several characteristic reactions. It was known in the Middle Ages under various names, among them *sal-aremonicum*. Agricola (*De Nat. Fos.*, iii., p. 206) notes its characteristic quality of volatilization. "Sal-ammoniac . . . in the fire neither crackles nor flies out, but is totally consumed." He also says (p. 208): "Borax is used by goldsmiths to solder gold, likewise silver. The "artificers who make iron needles (tacks?) similarly use sal-ammoniac when they cover the "heads with tin." The statement from Pliny mentioned in this paragraph is from xxxiii., 29, where he describes the *chrysocolla* used as gold solder as made from verdigris, *nitrum*, and urine in the way quoted. It is quite possible that this solder was sal-ammoniac, though not made in quite this manner. Pliny refers in several places (xxxiii., 26, 27, 28, and 29, xxxv., 28, etc.) to *chrysocolla*, about which he is greatly confused as between gold-solder, the copper mineral, and a green pigment, the latter being of either mineral origin.