CHARACTERISTICS OF MINERAL DEPOSITS

Maria Boni
University of Naples "Federico II", Italy

Keywords: mineral deposits, diamonds, chromite, base metals, gold, iron, manganese, industrial minerals

Contents

Summary

Mineral deposits, where a few elements of interest have been concentrated by nature above the average crustal geochemical abundance, supplied valuable material to human life long before they became objects of commercial exploitation. They can be classified into metallic mineral deposits, nonmetallic (or industrial) deposits, and building or ornamental stones. Mineral deposits have a close link to global geologic processes and reflect important changes in Earth's history. In this topic only a small selection of important deposit types, derived both from surface and from subsurface processes, has been treated. Among the deposits derived from magmatic processes, diamonds, chromite, and platinum group elements are discussed, while there are a few articles on sedimentary exhalative, Mississippi Valley type, volcanogenic massive sulfides, porphyry copper, and gold deposits, all regarding the wide field of hydrothermal deposits. Other papers are dedicated to iron and manganese ores and to a wide selection of industrial minerals.

1. Introduction

> *"Many persons hold the opinion that the metal industries are fortuitous and that the occupation is one of sordid toil, and altogether a kind of business requiring not so much skill as labour. But as for myself, when I reflect carefully upon its special points one by one, it appears to be far otherwise. For a miner must have the greatest skill in his work, that he may know first of all what mountain or hill, what valley or plain, can be prospected most profitably, or what he should leave alone; moreover, he must understand the veins, stringers*

and seams in the rocks. Then he must be thoroughly familiar with the many and varied species of earths, juices, gems, stones, marbles, rocks, metals and compounds. He must also have a complete knowledge of the method of making all underground works."

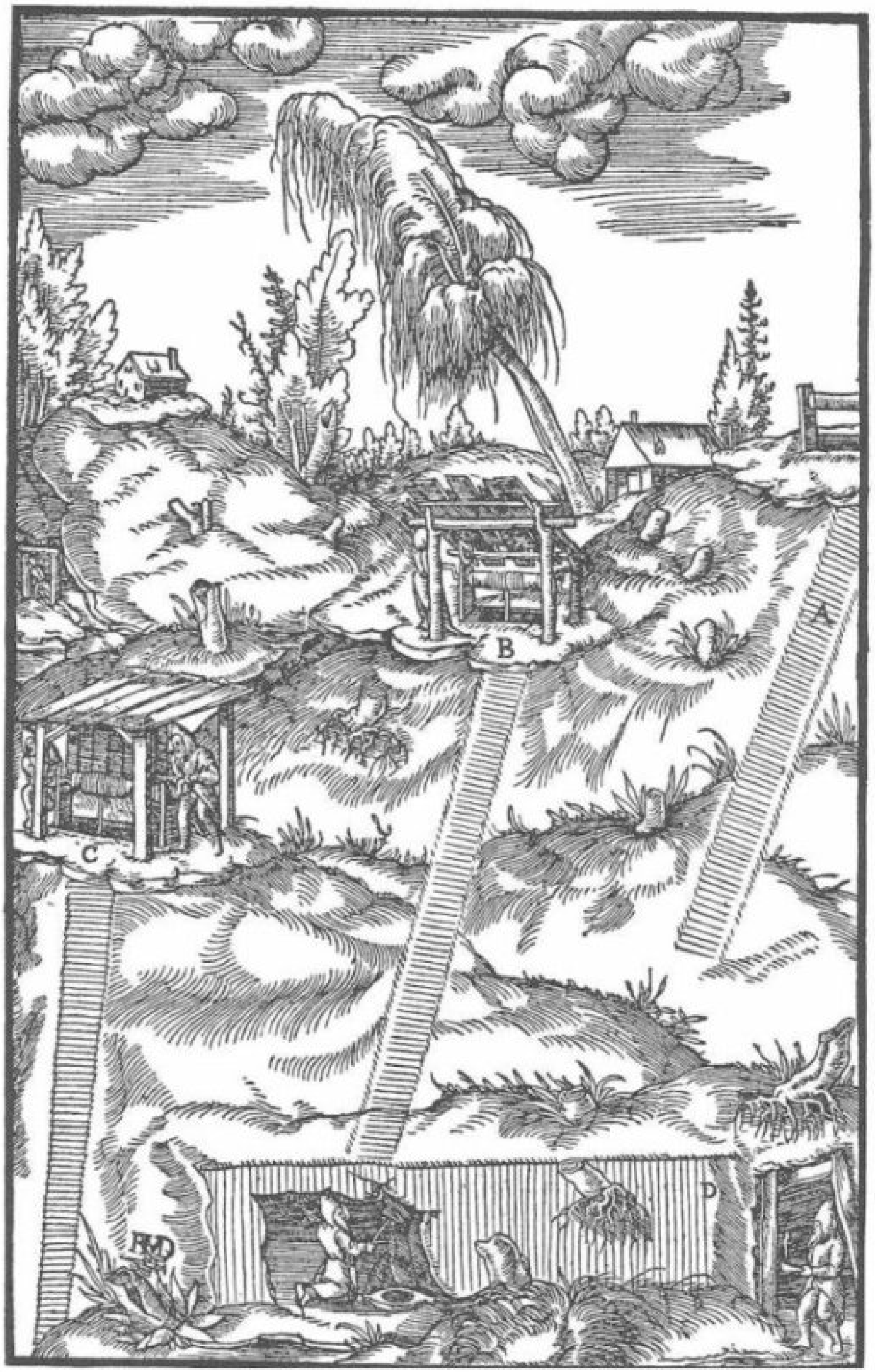

Figure 1. Three inclined shafts, of which A does not yet reach the tunnel; B reaches the tunnel; to the third, C, the tunnel has not yet been driven. D-tunnel. Original legend from Agricola, 1556; translation by Hoover and Hoover, 1950.

This is the introduction to Book I of Agricola's treatise *De Re Metallica* (1556), really the first exhaustive book on economic geology, mining, and metallurgy ever written, in the translation of Hoover and Hoover (1950). In this book is displayed all the scientific and naturalistic knowledge of more than 2000 years of empirical mining, interspersed with alchemistic and magic matter-of-fact notions (Figure 1). Nevertheless, this introductory concept is probably one of the best definitions ever made of the work of the exploration and ore deposit geologist. In modern times, the study of mineral deposits has evolved into an applied science employing not only detailed field observations (as in Agricola's times), but also sophisticated laboratory techniques and even computer modeling to build genetic hypotheses, in order to help geologists to find new orebodies or exploit the known ones more efficiently.

Minerals, also called "ore deposits," are important to civilization, because they represent the work that nature does for us. They supplied useful or valuable material to human life long before they became objects of commercial exploitation. Most ore deposits contain one or more minerals in which the elements or substance of interest have been concentrated sufficiently above the average crustal abundance to have potential economic value. Therefore, ore deposits by definition form only where geological processes concentrate elements into ore minerals, and then concentrate the latter again into a single, and limited, location. The concentration of the element or compound of interest in an ore is referred to as the *grade* of a deposit. To be graded, however, a mineral deposit must attain a minimum size, because no matter how high its grade, a deposit must contain enough ore to pay for the equipment, labor, and cost of extraction. The minimum concentration needed to extract the ore at a profit is known as the *cut-off* grade.

It is important to remember that mineral deposits are not only there "to have their (former exploration) sites remediated from environmental impact," as is often said among the general public when bringing up the subject of mining, and often discussed in the media along the same lines. In C. Morrissey's article, *Mineral Resources: Nature's Most Versatile Life Support System*, this kind of involuntary, or even outspoken, misunderstanding is plainly reported. The author shows clearly how mineral raw materials prove their versatility by playing essential roles in every material aspect of life, and by being continuously employed in new uses as lifestyles change. It is virtually impossible to look around in the human inhabited world and see anything not made from minerals or without mineral-based tools. People in affluent societies use hundreds of mineral products in direct and indirect ways every day. Even most of the new tools and gadgets people now use for work, leisure, and convenience (mobile phones are a good example) depend in some way on metals and their derivatives. People usually do not realize this, and since minerals are generally raw materials rather than end products, mineral producer (that is, mining) companies make little effort to explain their usefulness to the general public with effective advertisement campaigns, as other producers (of food, cars, or cosmetics, for instance) do so well.

Mineral deposits can been classified into two broad categories:

a) Metallic mineral deposits (for instance, containing copper, lead, iron, and gold), from which the corresponding metals can be extracted. In this category are also traditionally included diamonds and other gemstones. Turning to minerals, there are about 3,000 named species of which about half have practical uses. With many of them the main or only use is as a source of the metals they contain.

b) Nonmetallic (or industrial) deposits (for instance, containing clays, mica, and zeolites), where the minerals that make them up are useful on account of their specific chemical or physical properties. It is important to evaluate correctly the variety and practical importance of industrial minerals, which merge with another major group of natural resources, exemplified by building stone and natural aggregates.

The third category of deposits (building stone and natural aggregates, including both building and ornamental stones, which is not treated fully here) is of growing commercial interest, but its value is not always subject to variable market prices at a global scale, as in the case of the other commodities mentioned. Rather prices are related to the peculiar characteristics of the materials and to the variable demand for them which often depends on the development of particular building techniques, or simply on fashion or architectural whims.

In this topic dedicated to the geology of metallic and nonmetallic mineral resources, there are several papers in which a number of authors discuss mineral deposits belonging to the first two categories above. P. Lattanzi has written an introductory chapter, E*conomic Minerals: a Review of Their Characteristics and Occurrence*, dedicated to the mineralogy of the ore deposits.

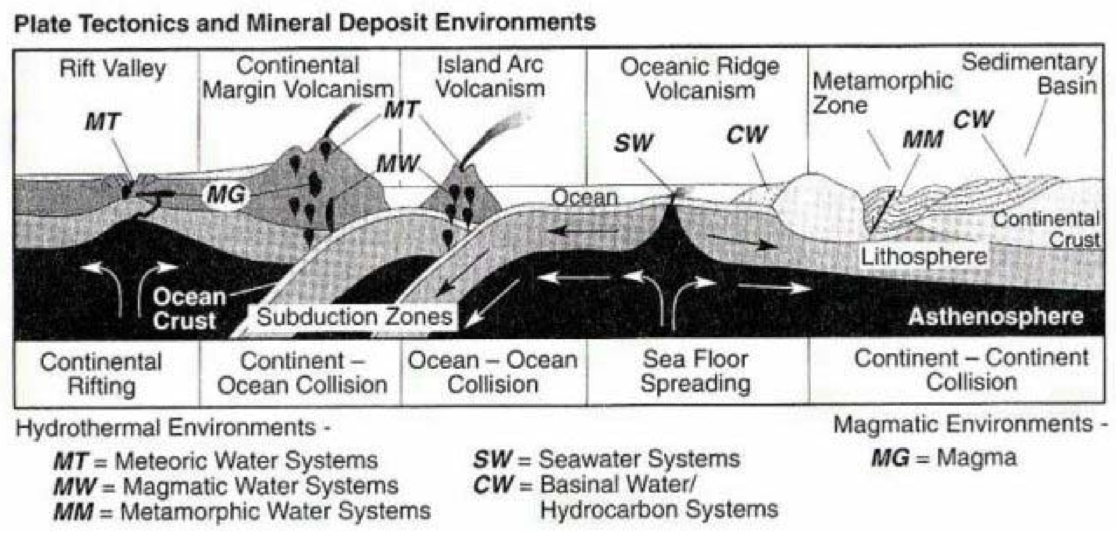

Figure 2. Plate tectonic environments, showing their relation to ore-forming magmatic and hydrothermal processes. Source: Kesler, 1994.

-
-
-

Bibliography

Agricola Georgius. (1556). *De Re Metallica*. Translated from the first Latin edition by Hoover H.C. and Hoover L.H (1950), 638 pp. New York: Dover. [The oldest textbook on mineral deposits, also useful for mining engineers and archeologists.]

Bates R.L. and Jackson J.A. (eds.) (1987). *Glossary of Geology, Third Edition*, 788 pp. Falls Church, VA: American Geological Institute. [Very useful to check scientific definitions and correct spelling.]

Kesler S.E. (1994). *Mineral Resources, Economics and the Environment*, 391 pp. New York: Macmillan College Publications. [A good combination of ore deposits geology and discussion on environmental impact and remediation.]

Kirkham R.V., Sinclair W.D., Thorpe R.I. and Duke G.M. (eds.). (1993). *Mineral Deposits Modeling*, 770 pp. Geological Association of Canada Special Paper No. 40. [One of the pillars of mineral deposits modeling: for advanced readers.]

Misra K.C. (2000). *Understanding Mineral Deposits*, 845 pp. Dordrecht, Netherlands: Kluwer Academic. [The most recent textbook on mineral deposits, with reference to exploration and economics.]

The most used journals among mineral deposits operators are:

Economic Geology, Bulletin of the Society of Economic Geologists, Lancaster Press Inc., Lancaster USA.

Mineralium Deposita, Bulletin of the Society of Geology Applied to Mineral Deposits, Springer Verlag, Heidelberg, Germany.

Biographical Sketch

Maria Boni was born in Naples, Italy in 1948. She received her bachelor's degree (Italian Laurea) in Geological Sciences at the University of Naples in 1970, with a thesis on the bauxite deposits of the Matese Mountains, Campania, Italy. From 1971–1976 she was assigned several research scholarships at the University of Naples. From 1976–1979 she researched "Palaeokarst Ore Deposits in SW Sardinia, Italy" at Heidelberg University, Germany, obtaining her Ph.D. in 1979. From 1974 to 1982 she taught various courses in geology and related subjects at the University of Naples, and from 1981 to 1983 she was a researcher at the University of Naples.

In 1982 and 1983 she was awarded a British Council bursary for a postdoctoral position at the Mining Geology Division of Imperial College, London. In 1991 she was shipboard participant at the Leg 139 of ODP (Sedimented Ridges I at Middle Valley, Juan de Fuca Ridge). Since 1983 onward she has been Associate Professor in Economic Geology at the University of Naples, and since 1995 she has also lectured in economic geology at the University of Heidelberg.

She is a member of the Society for Geology Applied to Mineral Deposits (SGA), and the Society of Economic Geologists (SEG), and she was an editorial board member for the SEG until 2004. She has published articles in more than 110 publications (80% peer reviewed) and 80 abstracts. The main themes of her research are base metal hydrothermal deposits; the sedimentology and diagenesis of carbonate rocks; non-sulfide zinc ores; fluid flow, dolomitization, and mineral deposits; geochemical mapping for environmental studies; and lead isotopes in archeometry.