

Hypogene & Supergene

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Figure 1 (left). Hypogene galena with calcite, 9.1 cm high, Nicolai mine, Dal'negorsk, Russia. Stuart and Donna Wilensky specimen, Stuart Wilensky photo.

Figure 2 (above). Supergene pyromorphite, 3.5 x 3 cm, Losa mine, Guilin, Guangxi, China. John Rakovan specimen, Fabre Minerals photo.

Many mineral deposits that are rich in well-crystallized specimens form from geologic waters. In the present installment of this column, we begin our look at several terms that describe minerals formed from aqueous solutions. The article in this issue on fluorites from the Blanchard mine group (pages 380–89) describes their formation as *hypogene*. The term *hypogene* is used in the geological literature in several different ways: to describe geologic processes, and their resultant features, occurring within and below the earth's crust; to describe a mineral deposit formed from aqueous solutions that originated at depths below the deposit and ascended through the crust; and to describe those solutions and that environment. It is in the last context that *hypogene* is most often used in association with mineral deposits. Although the term does not imply any other characteristics of the waters of formation, it is often the case, because of their deep origin, that they are hydrothermal, or hot waters (to be discussed in a future column).

In ore deposits the primary minerals that form from hypogene processes—particularly sulfide minerals such as pyrite, FeS_2 ; chalcopyrite, FeCuS_2 ; galena, PbS ; and sphalerite, ZnS —can be altered near the earth's surface by low-temperature, oxidizing meteoric waters to secondary, or *supergene*, minerals. In this process, descending groundwaters oxidize and dissolve primary sulfide minerals. The resulting dissolved metals (e.g., Cu, Zn, Pb, and Fe) are then often carried downward in solution and may eventually precipitate to form two zones of secondary minerals, one above and the other below the water table. Conditions above the water table are usually

oxidizing; thus, secondary minerals that are stable under these conditions form in this zone. Examples of such minerals include malachite, $\text{Cu}_2\text{CO}_3\text{OH}_2$; azurite, $\text{Cu}_3(\text{CO}_3)_2\text{OH}_2$; cuprite Cu_2O ; pyromorphite $\text{Pb}_5(\text{PO}_4)_3\text{Cl}$; and smithsonite, ZnCO_3 . Beneath the water table, conditions are usually reducing, and secondary minerals that form in this the zone of supergene enrichment are dominantly sulfides, such as covellite, CuS , and chalcocite, Cu_2S ; however, even native metals such as copper may precipitate in this environment.

For further reading on these and other related terms, see Misra (1999), Robinson and Scovil (1994), and Park and MacDiarmid (1975).

REFERENCES

- Misra, K. C. 1999. *Understanding mineral deposits*. Boston: Kluwer Academic Publishers.
Park, C. F., and R. A. MacDiarmid. 1975. *Ore deposits*. San Francisco: W. H. Freeman and Company.
Robinson, G. W., and J. A. Scovil. 1994. *Minerals*. New York: Simon & Schuster. □

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