

GANGUE

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Gangue (pronounced “gang”) is the term used to collectively describe the valueless minerals in an ore deposit. This view of gangue equates value with ore minerals. The table gives the most common gangue minerals (Rimstidt 1997). As one reads through this list, however, it becomes obvious that many gangue minerals may be of great value in the mineral-specimen market. Also, inclusion in the table does not preclude a mineral from being economically important in some deposits; it only indicates that it is commonly found in uneconomic concentrations associated with other minerals that are ores. For example, fluorite (our major source of fluorine) is a primary ore mineral in many deposits, such as the manto fluorite deposits of the Buenavista-Encantada and El Tule mining districts, northern Coahuila, Mexico (Temple and Grogan 1963; Rakovan 2003), but it is a common gangue mineral in most Mississippi Valley-type (MVT) lead-zinc deposits (Misra 1999). An important exception to this last example are anomalously fluorite-rich MVTs such as those found in the Kentucky-Illinois fluorite district (once the world’s largest source of fluorite ore; Park and MacDiarmid 1975).

In the previous Word to the Wise column (Rakovan 2005), we explored the metasomatic alteration of rocks, a natural process that is often associated with hydrothermal activity and ore deposit formation. Gangue can consist of the altered and unaltered host rocks of a deposit as well as non-ore minerals that were transported to the deposit in solution. Although gangue is not economically valuable, it can prove very useful. Specifically, gangue formed by both metasomatic alteration and precipitation during ore formation can yield a wealth of information about the origins and physical conditions of the ore-forming fluids (Barnes 1997). For example, because gangue minerals such as quartz and calcite are transparent in thin section, they are most often used for fluid inclusion studies (Roedder 1984) rather than the sulfide ore minerals that are commonly opaque. Fluid-inclusion studies give us information such as the temperatures at which the minerals formed and the salinity of the fluids from which they precipitated. This in turn

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Figure 1. Apatite and magnetite (gangue and ore respectively) from the Dashkesan (Dashkezan) Co-Fe deposit, Dashkesan, Rayonu, Azerbaijan. Specimen measures 7 x 5.5 cm.

can increase our understanding of ore formation and guide future exploration.

Separation of gangue from ore minerals can be one of the major obstacles in the successful development of an ore deposit. Because the two are usually intimately intergrown (fig. 1), crushing of ores to a fine grain size is usually required. Once the various minerals are mechanically liber-

Common gangue minerals.

silicates

chalcedony
 opal
 quartz

carbonates

ankerite
 aragonite
 calcite
 cerrusite
 dolomite
 kutnohorite
 magnesite
 rhodochrosite
 siderite
 smithsonite
 strontianite
 witherite

sulfates

alunite
 anglesite
 anhydrite
 celestine
 gypsum

halides

fluorite

sulfides

pyrite

Source: Modified from Rimstidt (1997).

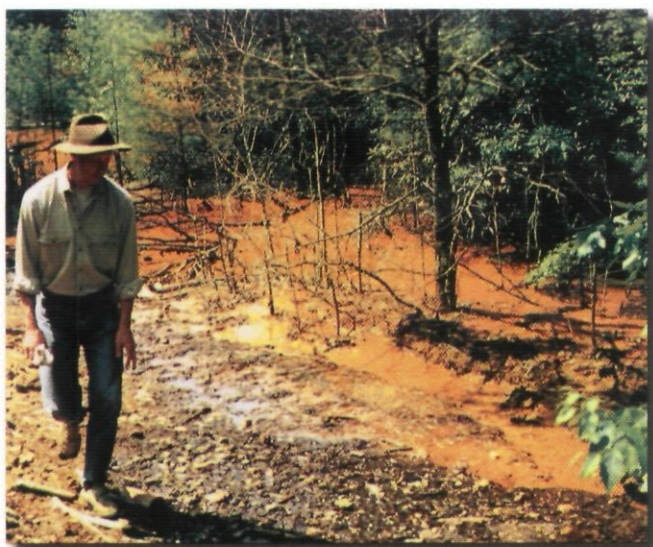


Figure 2. Acid mine drainage with typical *yellow-boy* precipitation (amorphous iron oxide) that forms from the iron released by pyrite during oxidation, Gossan Lead, Galax, Virginia.

ated from one another, differences in physical and chemical properties (i.e., density, magnetism, wetting abilities, solubility, and so on) can be exploited to separate them and to concentrate the ore minerals.

The majority of metal ore minerals are sulfides (i.e., chalcocite, Cu_2S ; sphalerite, ZnS ; and molybdenite, MoS_2). Because of the abundance of iron in the earth's crust (roughly 6 percent) pyrite, FeS_2 , is associated with almost all sulfide ore deposits. However, it is rarely of economic importance and thus is often a gangue mineral. Pyrite is also a common gangue mineral in coal deposits. In mine development most gangue minerals end up on the waste pile. When it comes to pyrite, this leads to one of the major environmental problems associated with mining: acid mine drainage (AMD). AMD is formed by inorganic and microbially mediated oxidation that occurs when oxygen-rich surface water comes in contact with pyrite. The resulting water is usually high in acidity (low pH) and dissolved heavy metals that stay in solution (and are thus bioavailable) until the pH is increased (fig. 2). Acidic, metal-rich waters can also form deep within mines that allow the entry of oxygen and access to buried pyrite and other sulfides. Problems associated with AMD include contaminated drinking water, disrupted growth and reproduction of aquatic plants and animals, and accelerated corrosion of steel in structures such as bridges (Azcue 1999).

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