Environmental geology

Science, Physics

Environmental Geology Teacher’s Today’s and Period Assignment

Environmental Geology

Q. 1. What are the differences between sulfide minerals, sulfate minerals and carbonate minerals? Give three examples of metal sulfide minerals that have commercial value (provide names and chemical formulae). Give example locations where these sulfide minerals have been extracted.

Sulphide and Sulphate minerals both consist of the element Sulfur. The Sulphate/sulfate minerals are the salts of sulfuric acid. They are very rarely found and are subjected to locality of the region. Sulphates constitute of the anion SO4-2 (Geosci). Sulfide or sulphide minerals are compounds of sulfur comprising of other metals, which may be one or more. Sulphides have a simple formula, and show properties exhibited by metals, like luster and conductivity. Sulfides are identified by the anion –S-2 (Britannica). Like Sulphides and sulphates, carbonates are also non-silicates. The carbonates are one of those minerals which are not localized and found in abundance and are distributed far and wide (GeoSci). When a carbonate ion, CO32- , is present in any mineral family it s referred to as a carbonate mineral.

Lead sulphide, also known as Galena, is the main ore of lead. Its chemical formula is PbS (GeoSci). The city Galena, in Illinois is known for and named after the mineral (Britannica) .

Zinc Sulphide, also known as Sphalerite; has the chemical formula ZnS (GeoSci). Known to miners as Black Jack, have been known to be extracted in the cities of Dubuque and Iowa (Ludvigson and James).

Iron sulphide, also known as pyrite has the chemical formula FeS. More commonly it is also referred to as the Fool’s Gold (GeoSci). It is found in

Illinois, Wisconsin, Missouri, and Grant county (Galleries).

Q. 2. There are a number of mines which have been developed in different parts of the world which now release acid mine drainage (AMD). For the following three mines or mine districts, 1) Iron Mountain Mine in Shasta County, Redding, California, 2) Britannia Mine in Britannia Beach, British Columbia, Canada, and 3) the Rio Tinto mining district near Huelva, Spain, describe the years of operation, the type of ore mined, and the scale and nature of wastes generated from the mining activities.

1. Iron Mountain Mine in Shasta County, Redding, California: iron, gold, silver, zinc, copper and pyrite were mined. The mine operated from the 1860's up to 1963. The mine generated cadmium, copper, zinc, copper compounds, zinc compounds as wastes, which contaminated the Sacramento River. Richmond mine has the highest acidic mine water; with pH values as low as -3. 6, metal concentrates 200g/L, and sulphate concentrates 760g/L.

2. Britannia Mine in Britannia Beach, British Columbia, Canada: was a copper mine, which operated from 1900 to 1974. It also generated zinc sulphide and pyrite (Mills). Intertidal discharge from the mine resulted in sub-aqueous deposits in Howe Sound, which was in excess of 44 million tones. Also 980 mg/l copper, 170 mg/l ferrous iron and 1. 61 g/l ferric iron (pH 3), was found in the portal discharge (Mills).

3. Rio Tinto mining district near Huelva, Spain: are believed to be the oldest mines in the world. They are believed to be the fabled King Solomon's mines. A Couple of nearby villages have also been named after King Solomon (Andalucia). The Roman era also saw iron mined from these mines. It is mined for iron, copper, and silver. The mine is still operational. The ferrous

ores from the mine are mainly responsible for the water of Rio Tinto being contaminated and being red in colour (Andalucia).

Q. 3. Describe the primary geochemical reactions which contribute to the generation of acid mine drainage (AMD) from sulfide-rich mine wastes?

The flowing of acidic waters from mines is known as acid mine drainage. It occurs when iron sulphide ore, which is found in conjunction with other metals, is oxidized (Groundtruttrekking). AMD occurs in sulphide mines where a metal sulphide ore is present. The oxidation of the ore results in production of sulfuric acid and heavy metals. Acid is generated when a rock which can generate acid is crushed and exposed to environment and oxygen.

Q. 4. Describe the primary reactions which contribute to the neutralization of AMD through natural geological processes?

AMD is neutralized through dissolution of carbonate and silicate minerals. Considering the example of plagioclase (Gardguide, 2. 4. 6):

$MeCO_3 + H^+ = Me^{2+} + HCO_3^-$

Me is the magnesium divalent cation. Magnesium silicates have the tendency to neutralize mine effluents. Magnesium carbonate dissolves quite quickly, which makes it very effective at consuming acid (Gardguide, 2. 4. 6).

Q. 5(a) Describe two remedial actions taken at the Iron Mountain Mine site to reduce AMD and describe how these actions have helped to improve the environment.

Capping Off: Certain selected parts that had either cracked or caved in, were capped off by removing the tailings from the Minnesota flats, and by filling

them into the black flat pit (EPA, 02-03). The capping off of the black flat pit has eliminated the direct exposure of the contaminants into the water by creating a barrier between the water and the contaminants. It also reduces erosive activity which in turn leads to reduced exposure of contaminants. But this measure does not lower the toxicity of the water level which has already been contaminated, rather reduces further contamination (EPA, 02-03).

Lime Neutralization Plant: the EPA built a lime neutralization plant to neutralize the AMD (EPA, 02-03). The process consisted of an aerated simple mix (ASM). The plant consisted of conveyance systems that carried the water through the plant, which was treated there. After treatment the water had higher ph levels, and was released into the Spring Creek. The sludge was utilized at Brick Flat Pit. The plant was effective in removing more than 99% of contamination from the water.

The remedial actions have helped in considerable decrease in the acidity of water and lower the high metal content in water. The remedial actions have lead to a gradual increase in the ph of water and also the copper load in the water has cut down (OCAP, 02-03).

b) How long is AMD predicted to continue at this site? Will the remedial actions need to be continued, or is the clean-up complete?

The cleanup is continuing at this worksite with the EPA looking for a permanent low cost solution to protect the environment (Report, 2-17). The water treatment will have to continue until all the traces of sulfide deposits have withered away, and that could take up to 2, 500 to 3, 000 years (Report, 2-17)

Q. 6. A developing nation has a growth rate of 0. 5% per year. Given an

initial population of 80 million people, calculate the estimated population for 2050 assuming the growth increases exponentially. This country currently uses approximately 52 kg of a metal (denoted as Metal X) per person each year, but now is increasing its use at a rate of 1% per year. How much of Metal X will this country consume in 2050?

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