**.5 The Grade of an Ore**

The **grade** of an ore is the fraction by mass of the valuable material it contains. If:

The mass of the ore = M
The mass of valuable material contained = m
Then the grade (in %) = m/M \* 100

Sometimes, the ore is described in terms of its ore mineral content. It can then be converted to metals grade using the appropriate relative atomic masses.

For example, a rock containing 1% of chalcopyrite (CuFeS2) would have a grade of:

1 x 63.5
(63.5+ 56 +2x32)

= 0.34% Cu

where the atomic masses of Cu, Fe and S are 63.5, 56 and 32 respectively.

The grade above which a given deposit is not economic to mine is known as the **cut-off** grade. Ores well above this value are termed **high-grade**; those close to this value are termed **low-grade**.

The multiplication factor needed to reach the cut-off grade from the average crustal abundance is known as the **concentration factor**. As shown below, this can vary greatly from metal to metal. In general, the greater the concentration factor, the more expensive the metal.

|  |  |  |  |
| --- | --- | --- | --- |
|    | **Ave. crust** | **Ave. cut-off (%)** | **(%)Conc. factor** |
| Aluminium (AI) | 8 | 30 | 3.75 |
| Iron (Fe) | 5 | 25 | 5 |
| Copper (Cu) | 0.005 | 0.5 | 100 |
| Tin (Sn) | 0.0002 | 0.2 | 1000 |
| Gold (Au) | 0.0000004 | 0.0008 | 500 |
| Mercury (Hg) | 0.000008 | 0.2 | 25000 |

**1.6 Size-Grade Characteristics**

**Grade-tonnage plots usefully depict the metal available in a given deposit for different cut-off grades. There are two extreme deposit types: dispersed and confined. The grade-tonnage plots demonstrate how a small reduction in cut-off grade for the dispersed deposit can generate a significant increase in metals. Secondary enrichment also converts rock to ore.**

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|  | **grade tonnage plot**  |
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| --- | --- | --- | --- |
| Cut-off grade (per cent) | Reserves of ore/M tonnes ores | Average grade of reserves (per cent) | Reserves of metal/M tonnes metal |
| **0.8** | **50** | **2.0** | **1.0** |
| **0.4** | **200** | **1.0** | **2.0** |
| **0.2** | **800** | **0.5** | **4.0** |
| **0.1** | **3000** | **0.25** | **7.5** |

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| --- | --- | --- | --- |
| Cut-off grade (per cent) | Reserves of ore/M tonnes ores | Average grade of reserves (per cent) | Reserves of metal/M tonnes metal |
| **4.0** | **0.04** | **5.0** | **0.002** |
| **3.0** | **0.3** | **3.3** | **0.010** |
| **2.0** |  |  |  |
| **1.0** | **1.0** | **2.2** | **0.022** |
| **0.5** | **1.1** | **2.1** | **0.023** |

 | **grade tonnage plot** |
| **http://www.unalmed.edu.co/rrodriguez/genesis-depositos/lecture%201_archivos/fig1.6d.gif** | **grade tonnage plot** |

**Drag the definitions on left to the corresponding letter on the right by referring to the diagram(Metal - Leachate - Co2,so2 metale- Concentrate – Dust- Co2- Water table**

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