Extracting Metals by Alternative Methods
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- Mining Earth's resources
- Bioleaching and phytomining
- Summary activities
Extracting metals

Some unreactive metals, like gold and silver, are found in the Earth’s crust as pure substances.

Most metals are actually found combined with other elements, as **compounds** in **ores**. These metals must be **extracted** from their ores before they can be made useful.

The extraction of metals and minerals is the fifth-largest industry in the world, but mining for ores is expensive and can cause damage to the environment.
Impacts of extraction
Mining for ores

As mining for ores is expensive, it is only carried out where minerals are abundant enough for this to be profitable.

In industry, an ore must contain enough metal to make mining and extraction economical.

The value of ores changes over time due to society and technology.

For example, rocks containing only 5% copper would have been considered unprofitable in the 19th century, but today, most copper comes from ores containing 0.4 to 1% copper.
Finding alternatives

The Earth’s natural sources of ore are becoming scarce, and so new ways of extracting metals from low grade ores are being developed.

A low grade ore has a low concentration of metal.

Phytomining and bioleaching are used to extract copper from metal contaminated land and low grade ores.

They avoid the more traditional method of digging, moving and disposing of large amounts of rock.
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Bioleaching

New mining techniques can decrease the impact of metal extraction on the environment.

In bioleaching, metal ores are dissolved in a solution then mixed with certain bacteria. Depending on the type of bacteria, different metals will be ‘leached’ from the ores into the solution, ready for electrolysis or a displacement reaction.

Bioleaching uses less fuel than traditional extraction, and does not produce waste gases.
Purifying copper

Copper extracted from its ore by bioleaching or phytomining is impure. In order to purify the copper, it must be dissolved in an acid, such as sulfuric acid, then **electrolysis** is carried out.

The impure copper from the copper sulfate solution is attracted to the pure copper negative electrode. Titanium is used for the positive electrode.

Copper can also be extracted from solutions of copper sulfate by carrying out a displacement reaction using scrap iron.
Phytomining or bioleaching?

The table below compares bioleaching and phytomining.

<table>
<thead>
<tr>
<th>phytomining</th>
<th>bioleaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon dioxide is released when the plants are burnt</td>
<td>no waste gases are produced</td>
</tr>
<tr>
<td>plants take up land and may alter the ecology</td>
<td>90% of metal in the low grade ore is extracted</td>
</tr>
<tr>
<td>non-continuous process as it requires a long time for plants to grow and be harvested</td>
<td>uses less than 50% of the energy of traditional extraction methods</td>
</tr>
<tr>
<td></td>
<td>a very slow process that can take years</td>
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</table>

Which method would you use?
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