The Earth contains many valuable nonfuel minerals. Those metal-yielding minerals found in concentrated deposits called ores are mined and processed to produce metals.
Mineral Resources and Society

- More than a hundred nonfuel minerals are traded in the world market.

- These materials, worth billions of dollars to the world economy, are vital to industry, agriculture, and our own lives.
### Figure 16.02: U.S. net import reliance for selected nonfuel mineral materials (1999).

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Percent</th>
<th>Major Sources (2003–2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASBESTOS</td>
<td>100</td>
<td>Canada</td>
</tr>
<tr>
<td>BAUXITE and ALUMINA</td>
<td>100</td>
<td>Jamaica, Guinea, Australia, Brazil</td>
</tr>
<tr>
<td>FLUORSPAR</td>
<td>100</td>
<td>China, Mexico, South Africa, Mongolia</td>
</tr>
<tr>
<td>GRAPHITE (natural)</td>
<td>100</td>
<td>China, Mexico, Canada, Brazil, China</td>
</tr>
<tr>
<td>GEMSTONES</td>
<td>99</td>
<td>Israel, India, Belgium, South Africa</td>
</tr>
<tr>
<td>STONE (dimension)</td>
<td>90</td>
<td>Italy, Turkey, China, Mexico</td>
</tr>
<tr>
<td>POTASH</td>
<td>81</td>
<td>Canada, Belarus, Russia, Germany</td>
</tr>
<tr>
<td>TIN</td>
<td>79</td>
<td>Peru, Bolivia, China, Indonesia</td>
</tr>
<tr>
<td>IODINE</td>
<td>71</td>
<td>Chile, Japan</td>
</tr>
<tr>
<td>TUNGSTEN</td>
<td>70</td>
<td>China, Canada, Germany, Portugal</td>
</tr>
<tr>
<td>CHROMIUM</td>
<td>62</td>
<td>South Africa, Kazakhstan, Russia, Zimbabwe</td>
</tr>
<tr>
<td>PEAT</td>
<td>60</td>
<td>Canada</td>
</tr>
<tr>
<td>SILICON</td>
<td>56</td>
<td>China, Venezuela, Russia, Norway</td>
</tr>
<tr>
<td>DIAMOND (dust, grit, and powder)</td>
<td>52</td>
<td>China, Ireland, Russia, Ukraine</td>
</tr>
<tr>
<td>NITROGEN (fixed) AMMONIA</td>
<td>44</td>
<td>Trinidad and Tobago, Canada, Russia, Ukraine</td>
</tr>
<tr>
<td>COPPER</td>
<td>37</td>
<td>Chile, Canada, Peru, Mexico</td>
</tr>
<tr>
<td>GYPSUM</td>
<td>26</td>
<td>Canada, Mexico, Spain, Dominican Republic</td>
</tr>
<tr>
<td>SULFUR</td>
<td>24</td>
<td>Canada, Mexico, Venezuela</td>
</tr>
<tr>
<td>SALT</td>
<td>18</td>
<td>Canada, Chile, The Bahamas, Mexico</td>
</tr>
<tr>
<td>NICKEL</td>
<td>17</td>
<td>Canada, Russia, Norway, Australia</td>
</tr>
<tr>
<td>CEMENT</td>
<td>17</td>
<td>Canada, China, Thailand, Republic of Korea</td>
</tr>
<tr>
<td>IRON and STEEL</td>
<td>12</td>
<td>Canada, European Union, Mexico, Brazil</td>
</tr>
</tbody>
</table>

Who Consumes the World’s Minerals?

- The more developed nations consume the bulk of the world’s minerals.

- As the less developed nations’ economies expand, they will use a larger share of the world’s mineral supplies.
Import Reliance

- Many more developed nations such as the United States import a large percentage of their minerals.
- Some minerals come from politically volatile areas.
- Disruptions in the supplies from these nations could result in considerable economic hardship.
- More developed nations typically stockpile minerals to protect themselves against such possibilities.
Figure 16.03: Risky business. The United States imports some minerals from politically unstable countries.
Will There Be Enough?

- Most minerals are present in adequate quantities or can be replaced by various substitutes.

- Some—about 18 minerals we use—are in danger of falling into short supply within the near future.
16.2 Environmental Impacts of Mineral Exploitation: A Brief Overview

- The mineral production/consumption cycle produces extraordinary environmental impacts.

- The most noticeable occur in the mining and smelting phases.
Figure 16.04: Open pit mine. This aerial view of the Bingham copper mine in Utah shows the enormous impact of this activity.
Figure 16.05: Destruction from the Sudbury smelter.
16.3 Supplying Mineral Needs Sustainably

- Creating a Sustainable System of Mineral Production
  - Implementing the operating principles of sustainability—conservation, recycling, and restoration—can help human society create a more sustainable system of mineral production.
Figure 16.07: The future of the world’s minerals. This graph shows three possible scenarios on a hypothetical time scale.
Creating a Sustainable System of Mineral Production

- Recycling metals provides materials needed to manufacture goods at a fraction of the environmental cost of producing them from raw materials.

- This is in large part because using already processed and refined materials saves energy.

- Recycling can help to extend mineral supplies.
Conservation—Decreasing Product Size, Increasing Product Durability

- Using less material by downsizing products or by making them more durable will help stretch limited supplies.

- These steps will help promote efficiency and conservation:
  - reforming unsustainable laws
  - removing subsidies on raw materials
  - giving financial incentives to companies that use resources efficiently and incorporate recycled materials in their products
Meeting mineral demands sustainably will require efforts to minimize environmental damage from mining and other operations.

Tougher laws may be needed.

Laws that exempt the mining industry from environmental protection may need to be changed.

Better efforts to restore the damage to natural systems caused by mineral production are needed in many countries.
16.4 Expanding Reserves

- Future demand cannot all be satisfied by recycling and conservation efforts.

- Some new minerals must be mined.
Many factors determine the size of mineral reserves.

One of the most important is the price.

Reserves tend to expand as prices rise, because companies are willing to spend more to develop lower-grade ores.

Ultimately all mineral resources are finite.
Technological Advances Expand Reserves

- Technological improvements make it feasible to mine less concentrated ores, which helps expand reserves.

Factors That Reduce Supplies

- high labor costs
- interest rates
- energy costs
- environmental protection costs
Minerals from the Sea

- Mineral-rich nodules are found on the ocean’s floor.
- Although they appear to be economically feasible to mine, little is known about the environmental impact.
- Questions of ownership also plague their exploitation.

Figure 16.09: Manganese nodules. Lying on the ocean's floor, these nodules range from the size of peas to that of oranges.
16.5 Finding Substitutes

- Substitution of one resource for another that has become economically depleted has been a useful strategy in the past.

- It may not work in all cases.

- Substitutes have limits, and some materials have no suitable alternatives.
16.6 Personal Actions

- Individual action is vital to building a sustainable future.

- Steps you can take:
  - buying durable products
  - recycling
  - choosing recycled materials