

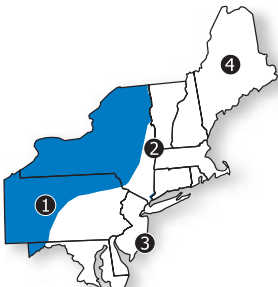
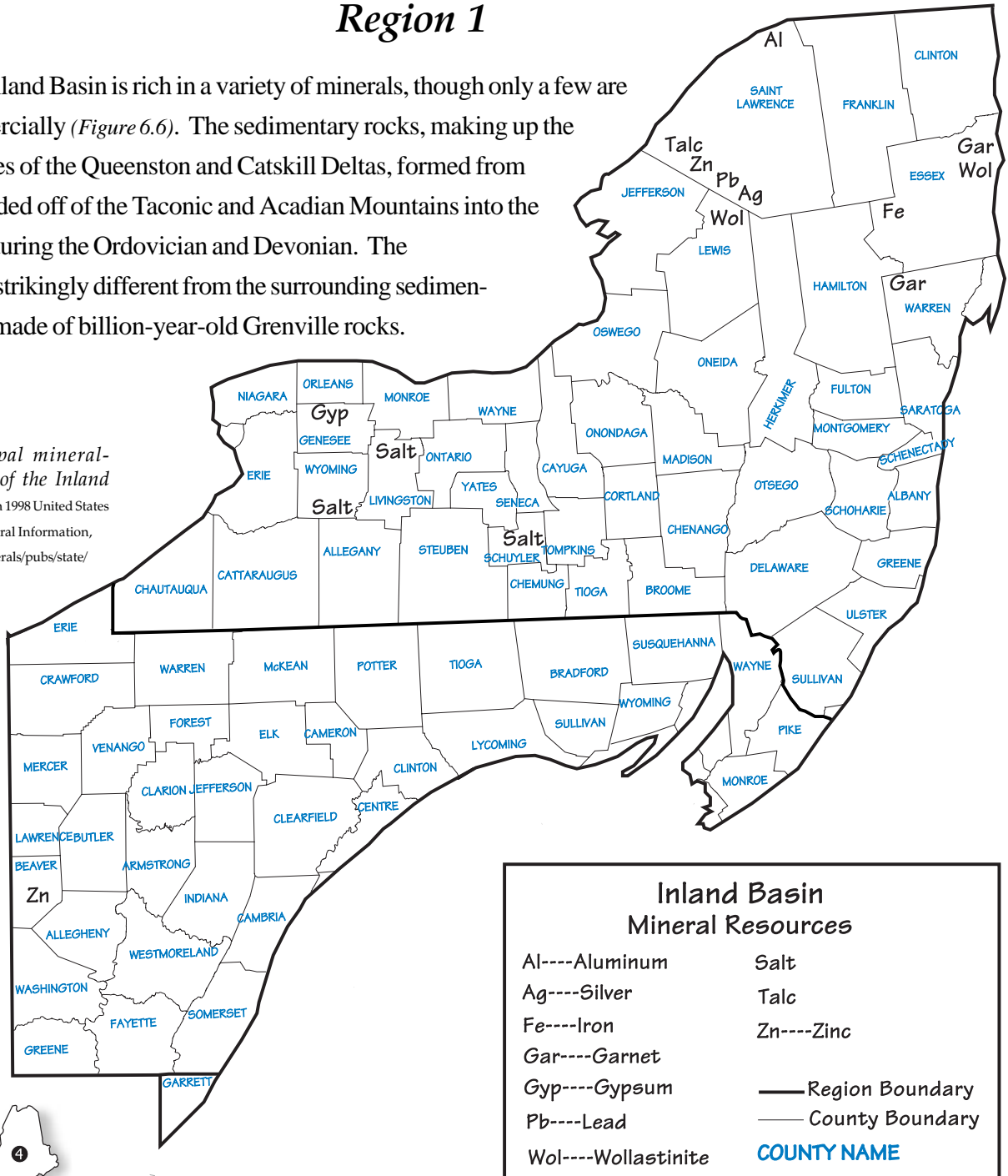


Mineral Resources

Mineral Resources of the Inland Basin Region 1

The Inland Basin is rich in a variety of minerals, though only a few are mined commercially (Figure 6.6). The sedimentary rocks, making up the thick sequences of the Queenston and Catskill Deltas, formed from sediments eroded off of the Taconic and Acadian Mountains into the inland ocean during the Ordovician and Devonian. The Adirondacks, strikingly different from the surrounding sedimentary rock, are made of billion-year-old Grenville rocks.

Figure 6.6: Principal mineral-producing localities of the Inland Basin. Figure adapted from 1998 United States Geological Survey State Mineral Information, <http://minerals.usgs.gov/minerals/pubs/state/>



Between the sedimentary rocks of the basin and the igneous and metamorphic rocks of the Adirondacks, there is a wide diversity in the principal mineral resources found in the region, including metallic minerals such as iron, zinc and illmenite, and non-metallic minerals such as gypsum and salt.





Metallic Minerals

in Grenville Rocks:

The Precambrian **Grenville rocks** of the Adirondacks, formed as the Grenville marine sediments were compressed and tacked on to North America, are seen poking through the younger sedimentary rock cover in the Adirondack

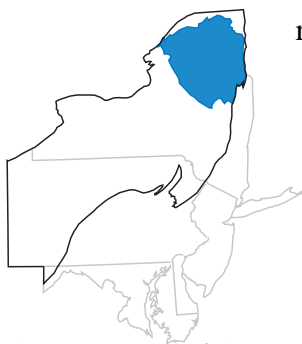


Figure 6.7: Precambrian Grenville rocks of the Adirondacks.

region of New York (Figure 6.7). The Grenville rocks include metamorphosed sedimentary rocks such as marble, gneiss, and quartzite, as well as anorthosite, an igneous rock crystallized from asthenosphere magma. With a mineral assemblage unique in the Inland Basin, the Adirondacks produce most of the metallic minerals in the region. The principal metallic mineral resources of the Adirondacks include iron, zinc, lead, silver, aluminum and titanium.

Iron in the Adirondacks is mined from the ore **magnetite**. Though geologists disagree on the origin of the iron, it may possibly have formed as deposits of iron in sedimentary rock that were later metamorphosed, or from concentration and later precipitation of magnetite crystals by **hydrothermal solutions**. Though iron may also be mined from other minerals, including **hematite** and **siderite**, and was at one time or another mined from every state in the Northeast, the only profitable site currently being mined for iron is in the Adirondack Precambrian gneiss.

Zinc, lead, and silver are often found in association with each other. Sphalerite is the most important ore mineral of zinc; galena is nearly the only regional source for obtaining lead; and silver is found in small amounts with galena. Both sphalerite and galena are found in commercial quantities in the Adirondacks. The minerals were initially concentrated by hydrothermal solutions and recrystallized through metamorphism when the Grenville sediments were compressed a billion years ago.

Until recently, **illmenite** was mined in the northeastern section of the Adirondacks where anorthosite rocks are found. Illmenite is an ore of titanium and was produced for use as a white pigment in paint. Titanium is also an important metal because of its lightweight nature, strength, and resistance to corrosion. As the Grenville rocks were compressed and metamorphosed, magma from the

see *Geologic History*, p. 3, for more on **Grenville Rocks**.



see *Rocks*, p.32, for more on **Grenville rocks**.



magnetite: Fe_3O_4

hematite: Fe_2O_3

siderite: $FeCO_3$

see *Minerals*, p. 131 for more on **hydrothermal solutions**.



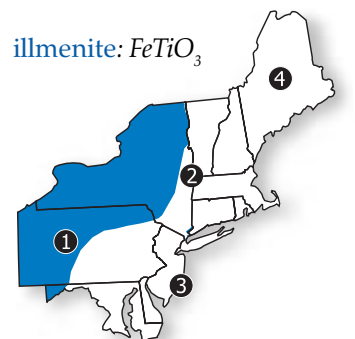
sphalerite: ZnS

galena: PbS

silver: Ag

Zinc is typically used in metal alloys and galvanized steel. **Lead** is necessary for batteries, communication systems, and building construction. **Silver** is used in photographic film emulsions, utensils and other tableware, and electronic equipment.

illmenite: $FeTiO_3$





Mineral Resources

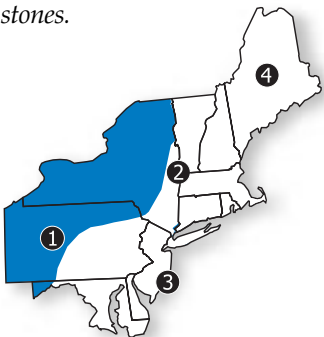
kyanite, sillimanite and andalusite all have the same chemical composition: Al_2SiO_5

The mineral name **hematite** has its origins in the Greek word *haimatos*, meaning blood. The vivid red pigment that iron lends to the mineral is valuable as a commercial pigment. Iron from hematite is also used in the manufacture of steel.

wollastonite: $CaSO_3$

Wollastonite is primarily mined for use in ceramic tiles, porcelain, and paints. It is also used as a replacement for asbestos in brake linings.

Gore Mountain garnets are used primarily as abrasives, not gemstones.



asthenosphere welled up through overlying rocks. The magma crystallized to form the igneous rock, anorthosite. Crystallization, however, did not happen all at one time. In a process known as crystal settling, the dense, heavy minerals crystallized first and sank to the bottom. Ilmenite, being a heavier mineral, became concentrated at the bottom of the crystallizing magma to form the large deposits of the ore that we see today.

Aluminum is also mined in the northernmost part of the Inland Basin. Aluminum is a common component of high-grade metamorphic minerals such as **kyanite, sillimanite** and **andalusite**.

in Other Rocks

Iron is also found in Pennsylvania and other parts of New York besides the Adirondacks. In particular, layers of limestone in the Clinton Group of rocks, located in the Silurian deposits at the edge of the Appalachian Plateau, contain deposits of **hematite** and siderite. These iron-rich layers stretch as far south as Alabama and are important indicators of sea level rise and fall. Hematite forms in shallow ocean water and siderite forms in relatively deeper water.

*The ready availability of **iron** at the surface made iron one of the earliest mined mineral resources in the US. Iron by itself is extremely rare, usually only occurring in meteorites. Iron is more often found in combination with other elements to form ores of iron, such as hematite, magnetite, siderite and pyrite (FeS), among others.*

Non-Metallic Minerals

The Inland Basin also has a diverse assemblage of non-metallic minerals, from the wollastonite, garnet, tourmaline, and beryl of the Adirondacks to the salt and gypsum of the sedimentary rocks further south.

in Grenville Rocks

The mineral **wollastonite** is currently mined in the Adirondacks in Lewis and Essex County, New York. Wollastonite formed in the Adirondacks when the Grenville limestone was metamorphosed and intruded by magma. Ninety-nine percent of the wollastonite produced in the US comes from New York.

The Adirondacks have also been a leading producer of **garnets**. Spectacular crystals, as large as 1 m across (though typically 2-2.5 cm across) have been found at the famous **Gore Mountain** garnet mine. Though the Gore





Mountain mine is now closed, the mine at nearby Ruby Mountain continues to be a leading producer of industrial garnet for use as an abrasive. When the Grenville sediments were compressed and metamorphosed over a billion years ago, the heat and pressure melted the deeply buried rocks to magma. As the magma pushed up through the overlying Grenville marble, gneiss and quartzite, it gradually crystallized to form anorthosite and other igneous rocks. When these igneous rocks were also metamorphosed, the heat and pressure recrystallized some of the rock to form the famous garnets.

in Evaporite Rocks

The Inland Basin was part of an inland ocean for hundreds of millions of years as the continents pulled apart and pushed together. A shallow restricted sea is the ideal environment for the evaporation of water and deposition of evaporite minerals. *Halite* (salt) and *gypsum* are examples of *evaporite* minerals. The Silurian, in particular, was a time of especially shallow seas with poor circulation in the region. It makes sense, therefore, that salt and gypsum are



Figure 6.8: Silurian rocks of the Inland Basin.

both found in Silurian sedimentary rocks exposed across central New York (Figure 6.8). The salt is at the surface, as natural salt springs, around Syracuse, New York. The gentle tilt of the Silurian rocks to the south means that salt is also found and mined underground south of the exposed salt beds, buried beneath Devonian rocks.

Salt has played a key role in the economy of upstate New York, and was the reason for the founding of cities like Syracuse, NY. The Retsof Mine near Geneseo, NY was the largest underground salt mine in the world before its collapse in 1993.

Gemstones

In addition to the abundance of metals and non-metallic minerals produced for industrial use in the Adirondacks, the Grenville rocks also contain the minerals tourmaline and beryl, prized as gemstones. Further south in Herkimer County, New York, in a patch of Cambrian rocks southwest of the Adirondacks, gem collectors seek out 'Herkimer diamonds.' Herkimer diamonds are not in

garnet: $A_3B_2(SiO_4)_3$ in which A and B may be substituted by different elements to produce a given variety of garnet.

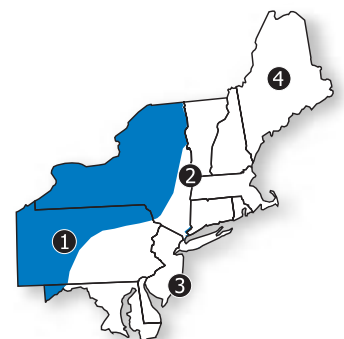
salt: NaCl

gypsum: $CaSO_4 \cdot H_2O$

see *Rocks*, p.35, for more on the formation of on **evaporite** minerals.



Salt is used throughout the Northeast for de-icing roads in winter and is also an important part of the chemical industry. Gypsum is mined for use in plaster and wallboard.





Mineral Resources

quartz: SiO_2

fact diamonds at all. Rather, they are very well formed, clear crystals of quartz found in the Little Falls dolostone. Dolostone is made in part of calcite, a mineral that is highly susceptible to reacting chemically with acids. The weakly acidic nature of rainwater and groundwater commonly dissolve away parts of dolostone, leaving open cavities in the rock. As groundwater, rich in silica, moved through the Little Falls dolostone, **quartz** crystallized in the cavities to form Herkimer diamonds.

The many faces of quartz

Quartz may be one of the most common minerals in the crust, but it does not always appear in the same form. There are a wide variety of different types of quartz, including coarsely crystalline and microcrystalline quartz. Several common minerals, including chert, agate and jasper, are actually varieties of quartz. Onyx, agate and petrified wood are fibrous, microcrystalline varieties of quartz known as chalcedony. Though agate is naturally banded with layers of different colors and porosity, commercial varieties of agate are often artificially colored. Flint, chert and jasper are granular microcrystalline varieties of quartz, with the bright red color of jasper due to the inclusion of small amounts of iron within the mineral structure. The most common, coarsely crystalline varieties include massive quartz veins, the distinct, well formed crystals of 'rock crystal', and an array of colored quartz, including amethyst (purple), rose quartz (pink), smoky quartz (gray), citrine (orange) and milky quartz (white).

