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History-Social Science Standard 7.3.5.

Student Edition

California Education and the Environment Initiative

Genius Across the Centuries

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

The Education and the Environment Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency
California Natural Resources Agency
Office of the Secretary of Education
California State Board of Education
California Department of Education
California Integrated Waste Management Board

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Special thanks to **Heal the Bay,** sponsor of the EEI law, for their partnership and participation in reviewing portions of the EEI curriculum.

Valuable assistance with maps, photos, videos and design was provided by the **National Geographic Society** under a contract with the State of California.

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None required for this lesson.

The First Jeans

An astute businessman, Levi Strauss knew opportunity when it came knocking. At the age of 24, he moved to San Francisco from New York. There, near the docks, he opened a shop that sold dry goods. His customers were people arriving in California hoping to strike it rich in the "Golden State." Strauss also imported fabric from around the world. As a wholesaler, he resold the cloth to local customers and people in other states.

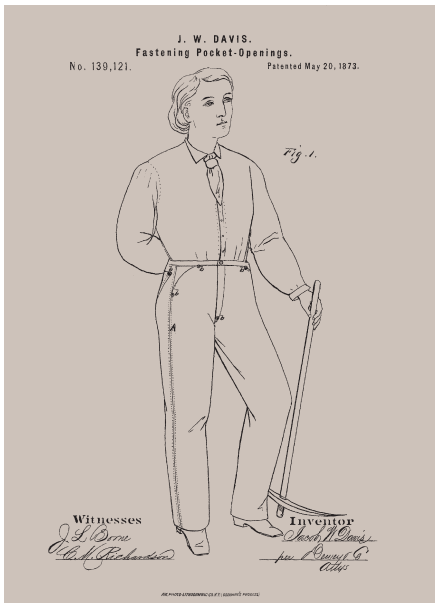
In 1872, Levi received a letter from one of his regular customers, Jacob Davis. Davis was a tailor working in Reno, Nevada. In his letter, he described a new process for making a pair of durable work pants. These pants were made of *denim* with heavy yellow stitching on two cotton-lined back pockets. Copper *rivets* added strength to the corners of the seams. Rivets are small metal bolts used to fasten two pieces of cloth together. They were traditionally used to make tents and covers for wagons. The pants Davis had made were already very popular and sold for $3 a pair (about 60 dollars today).

Davis wanted to patent his design for these new pants, but did not have enough money to do so. He invited Levi to file for the patent with him. Strauss quickly accepted the invitation and asked Davis and his family to move to San Francisco. Davis would supervise the manufacturing of the new pants by Levi Strauss & Co. Their patent was approved in May 1873, for what were originally called "waist overalls." The company designed them to be worn over regular clothes for protection while working. California's ranchers, gold miners, and sailors soon snapped up the sturdy denim trousers.

At first, the "501" trousers made by Levi Strauss & Company were simply called "overalls." It wasn't until the 1950s, that teenagers began calling them "jeans."

Denim and Dye: Products of Natural Systems

Long ago, fabrics were often named for the place where they were created. In the 1600s, a French family made a heavy fabric called "serge de Nimes." This cloth was from the town of Nimes.



Original waist overall patent

Cowgirls in jeans

At first, it was made partly of wool.

A new fabric, made entirely from cotton, not wool, soon was developed in Nimes. The name “de Nimes” stuck as the cloth was shipped from France to England for sale. This “de Nimes” cloth became popular because of its strength and durability. For this reason, the cloth had long been used for ship sails and military tents. Soon it was used to make trousers for working men.

The same raw materials used in the 1600s are used to make denim pants today, although the manufacturing process has been modernized. The yarn used in denim is made from cotton grown in warm climates. The southern United States, India, and China are major cotton producers. After the cotton bolls are harvested, they are cleaned and baled. The bales are then sold to textile mills. The mills comb the cotton fibers so they lay flat, side by side. The fibers are then twisted 2500 times to form yarn. Before denim cloth for blue jeans is made, this yarn must be dyed.

The characteristic blue color of denim jeans comes from indigo dye. People have used indigo pigment for thousands of years. Historically, indigo plants were the most common source for the dye. The leaves of the indigo plant were crushed and fermented to create the desired blue pigment. By the 1900s, the

Uncut denim

number of indigo plants could not keep up with the demand for the dye. In 1905, a man named Adolf Baeyer earned a Nobel Prize in chemistry for creating synthetic indigo. Synthetic indigo is what makes modern blue jeans blue. The yarn is dipped into the dye and dried 15–20 times. Blue jeans fade because the indigo layers gradually wash away.

After the yarn is dyed, the denim cloth is woven using half dyed-blue yarn and half white yarn. The blue yarn runs horizontally through the cloth and is called the *warp*. The white yarn runs vertically through the cloth and is called the *weft*. The overall color is blue as the blue threads are packed more tightly than the white threads. The Amoskeag Mill in Manchester, New Hampshire, made the original "Levi" denim. The denim cloth was then shipped to a San Francisco factory where the fabric was cut and sewn together with thick, yellow, cotton thread. Today, denim blue jeans are manufactured all over the world by many different clothing companies.

The Power of the Blue Jean

More than 130 years after the first pair was described, Levi's blue jeans have a global presence and appeal that is as durable as the fabric they are made from. These pants have been copied, counterfeited, and even banned in certain countries.

Interest in "jeans" was keen from the start. But the original blue jeans were

Manufacturing blue jeans

only available in the western United States. In the 1930s, Hollywood began producing movies featuring cowboys in "jeans." This created a buzz across the country. People from the East Coast traveled west for an authentic cowboy experience in California. As a souvenir, they bought their first pair of Levi's. It was not until the 1950s, that Levi's jeans were sold in stores east of the Mississippi River.

After 60 years of buying and selling Levi's in the United States, the jeans began trickling into countries in Europe and Asia. They traveled with soldiers and sailors during World War II. Magazines at that time spread the image of Americans in Levi's. British teenagers swarmed the docks when Merchant Marine ships pulled in. They bought blue jeans right off the sailors before the sailors could leave the ships.

In the 1950s, Communist countries banned Levi's from their markets to show their distaste for American culture. This created a "black market" for the jeans. Tourists traveling to Russia and other Communist countries often were offered more than $100 for their blue jeans on Moscow street corners. In Western Europe, jeans became worth far more than they were in America. As late as the 1990s, Scandinavian stores were selling Levi's for over $100 a pair.

Jeans

This blue jean craze created new opportunities for other kinds of pants made from denim. The fashion industry responded with "designer" jeans. Many different styles of jeans soon became available. Designers now personalize their jeans with sequins or stitching to differentiate them from the Levi's original.

In 1996, Levi's worldwide clothing sales were valued at $7 billion dollars. Today, some form of the jean is either made or sold in most countries. In spite of their widespread popularity, the image of the blue jean will always be something uniquely American, woven into California history.

The Facts About: Tea

Harvesting tea

Introduction

The Chinese have a saying: "Firewood, rice, oil, salt, sauce, vinegar, and tea are the seven necessities to begin a day." Though tea is last on this list, it is very important in China. Tea is the second most popular drink in the world. The first is water.

Some people say that tea was discovered by accident. According to the story, Emperor Shen Nong, a mythical figure, was boiling his drinking water when leaves from a nearby shrub fell into his pot. The drink gave the Emperor "vigor of body, contentment of mind, and determination of purpose." Tea was born!

At first, people mostly used tea to help with digestive and nerve problems. In 350 CE (Common Era), a scholar named Guo Po added the word for tea to a Chinese dictionary. He described it as a medicinal drink made from boiled leaves.

But over time, the uses of tea expanded. In 780 CE, Chinese author Lu Yu wrote a three volume book set entitled *Cha Jing* (The Classic of Tea). In it, Lu Yu described everything about

Tea plantation

tea—from how to properly grow it, to the best ways to prepare it. He also provided detailed descriptions of a ceremony for preparing and drinking tea. Tea and tea ceremonies first became popular in the imperial court of the Chinese emperors. They also became popular among common people in the countryside.

When Chinese began their love of tea, they harvested it in southern and southwest China. Then its popularity spread following the path of the Yangzi River. Farmers began to grow tea plants wherever conditions supported it.

Resources Used to Make Tea and Where They Came From

The first Chinese tea came from a small-leaved evergreen shrub or tree (*Camellia sinensis sinensis*) that grows to be 9 to 10 feet tall. Before farmers domesticated it, this tea tree grew wild in southern China and Southeast Asia (northern Vietnam, Laos, and Thailand). A different variety of shrub (*Camellia sinensis assamica*) grew wild in Yunnan province in southwest China and northern India. It has a broader leaf and grows 20 to 60 feet tall. It, too, was used to make tea and was widely cultivated.

Tea plants grow in tropical to subtropical climates and need at least 50 inches of rainfall per year. They prefer acidic, well-drained soil. They do not handle frost well, so they usually are not found in high elevations. However, people have been able to grow some high quality tea plants at elevations of 5,000 feet.

At first, people harvested tea from wild plants. But the demand for tea surpassed what people could harvest from the wild. During the Middle Ages, the Chinese grew tea on large plantations in almost a dozen provinces, from Shandong in the north to Guangxi in the south. The major tea-producing provinces included Yunnan, Sichuan, Fujian, Jiangsu, and Anhui. Some

tea was also grown in Hubei, Hunan, Guizhou, Guandong, and Jiangxi.

Methods of Making and Using Tea

It takes decades for a tea plant to become a high-quality tea producer. Tea is made in four stages. These include growing and picking, aging, drying, and finishing.

Farmers do everything they can to grow and harvest high-quality tea. New growth is the only part of the plant that is used for tea. The best teas are made from the bud and first two leaves at the end of a branch, which are called the "pekoe."

During the growing season, a plant will grow new buds every seven to ten days. Workers remove the buds by hand so they do not crush them. (They keep the trees pruned to shrub size to make it easier to pick the leaves.) Then they trim the plant so more buds will grow. By doing this, they can harvest new growth from the same plant two or more times each year.

Tea house in China

Once the tea leaves are picked, they are aged and dried. To age the tea, workers place the leaves out of the sun on a flat surface until they wilt. The longer the leaves age, the darker they become. That is how different types of tea are produced. To stop the "aging" process, the leaves must be dried. Leaves for green teas are aged for no more than two days before they are dried. The leaves for black teas are aged between two weeks and a month before they are dried. The leaves for oolong teas are aged somewhere in between. Leaves for the rarer (and more expensive) white tea are not aged at all. Growers shield the leaves from the sun while the plant grows and dry them immediately upon picking.

The traditional tea drying process changed over time. Originally, growers spread the leaves out in the sun to dry. Then, to make the process go faster, some growers began frying or roasting the leaves. The dry leaves were then either hand-rolled into a small ball or were pressed into blocks or bricks. The grower stamped their name or symbol into the block. Sometimes they added fruit and flowers as flavorings. The Chinese favorites were jasmine, rose, orchid, plum, and gardenia.

During the Song Dynasty (960–1279 CE), it was popular to crush the dried leaves into a powder and pour hot water into the powder to make a drink. During the Ming Dynasty (1368–1644 CE), people grew fond of putting the dried leaves inside a thin paper bag and allowing it to soak (or "steep") in hot water until it was ready to drink.

The Influence of Tea on Natural Systems

If even half of the people living in China right now drank one cup of tea each day, that would be 500 million cups of tea. Some people have estimated that one pound of processed tea makes about 200 cups. It would take about 2,500,000 pounds of tea to make those 500 million cups of tea. Since it takes about three pounds of fresh tea leaves to make one pound of dried tea, then you would need to pick seven and one half million pounds of tea to produce China's daily supply!

China's demand for tea has a long history. To meet that demand, during the Song Dynasty, tea plantations covered 15 of the southern provinces. Some of these farms were 10,000 acres or more. By the 1600s, when China's population reached 300 million, some of the largest tea plantations in China turned out 30,000 pounds of tea a year.

That is a lot of tea! It takes a lot of tea plants to make that much tea and growing those plants affects the natural systems where they grow. People began to farm tea wherever they could. First, they cleared the land of native plants. Then, they dug up the soil and planted tea plants in rows about four feet apart. If there was not enough rain to support the tea plants, they brought water from rivers and streams to the plantations. Weeding was also necessary to keep fungi and pests off the plants. Acres were planted with only one type of tea plant as far as the eye could see.

The Influence of Tea on Social Systems

For many Chinese, life revolved around harvesting, processing, and consuming tea. Every social group and class built special teahouses and tearooms. Here, they held elaborate ceremonies for drinking tea. People wanted porcelain teapots to prepare and serve tea. As a result, the porcelain industry grew.

As tea drinking became more popular, the imperial court attached great importance to tea farming and production. During the Tang Dynasty, tea became a form of tribute paid to the emperor. At first, "tribute teas" were the finest teas that a village or region grew and processed. In time, the emperor established royal plantations to grow tea under close supervision. The emperor's agents oversaw all parts of the production process. They set rigid standards and collected the tribute from the villagers who worked on the plantations. Custom dictated that green tribute teas be harvested and processed in a single day. The emperor took the very best.

By the time the Song Dynasty was in power, the tea harvest had become a time of big celebration. Before it began, officials made sacrifices to mountain and hillside gods. Men, women, and children picked leaves to the rhythm of a drum or cymbal. Young girls kept their fingernails a certain length so that they could pick the tea without the leaves touching their skin.

People grew and processed tea throughout China. Mostly people used tea that was grown locally. Village marketplaces and teahouses sold tea. However, a merchant class developed to move tea throughout China. These tea merchants created internal trade networks for transporting tea from place to place. They built big warehouses to store the tea. They soon had the responsibility of shipping specialty and tribute teas directly to the emperor and to other high-ranking officials throughout the country. Shipping tea became one of the uses for the famous "Silk Road."

The Facts About: Paper and Printmaking

Making paper

Introduction

The Chinese "discovered" paper as early as 105 CE (Common Era). For the next 500 years, they manufactured large amounts of it. While paper remained unknown to the rest of the world, the Chinese put paper to many uses. They used it for clothing, packaging, and decorating homes and temples. They even made the first toilet paper.

In the 300s CE, the invention of true ink provided a permanent way to write things down. Government officials and scholars used paper and ink to keep written records. They bound and circulated handwritten books. However, the number of books written before the Middle Ages was small because writing took such a long time that they were very expensive.

The invention of printing changed everything. Since the 100s CE, Buddhist monks had been carving sacred texts into pieces of stone. People discovered that they could rub the stones with dye or oils and then press paper against them, making a "copy" of what was on the wall. In the 600s, people began carving entire pages of text onto a single block of wood. They put true ink on the blocks and could print many copies of the same page. In 868 CE, the first woodblock-printed book appeared.

The Chinese began making toilet paper in the 500s. By the middle of the 1300s, China was producing between ten billion and one hundred billion sheets of toilet paper a year at a time when the West did not even know what it was.

By 1393, the Bureau of Imperial Supplies manufactured 720,000 sheets of toilet paper (2' x 3' per sheet) a year for use at the imperial court. In addition, it made 15,000 "special sheets" (3" square, thick, soft and perfumed) for the imperial family to use.

Resources Used in Paper and Printmaking and Where They Came From

The process of making paper combines several materials. The most important are plants with long, strong fibers, or rags and rope made from such plants. The Chinese used hemp, bamboo, mulberry, rice or wheat-straw, and silk.

Some of the plant fibers used for papermaking were cultivated. Others grew wild. Hemp, for example, had been growing in China for about 3,000 years. It was widespread across China, in Shaanxi province, Hebei province, and Fujian province. Bamboo was widespread south of the Huang He River. Paper mulberry grew wild in almost every province south of Inner Mongolia and east of Gansu. Rice grew mostly south of the Yangzi, and wheat north of it.

The other ingredients in Chinese paper came from sources that were easy to get. The Chinese used the juice from leaves of certain trees, like birch, to strengthen the fiber. The trees that provided the juice grew wild in northern China and the mountains of the south and west.

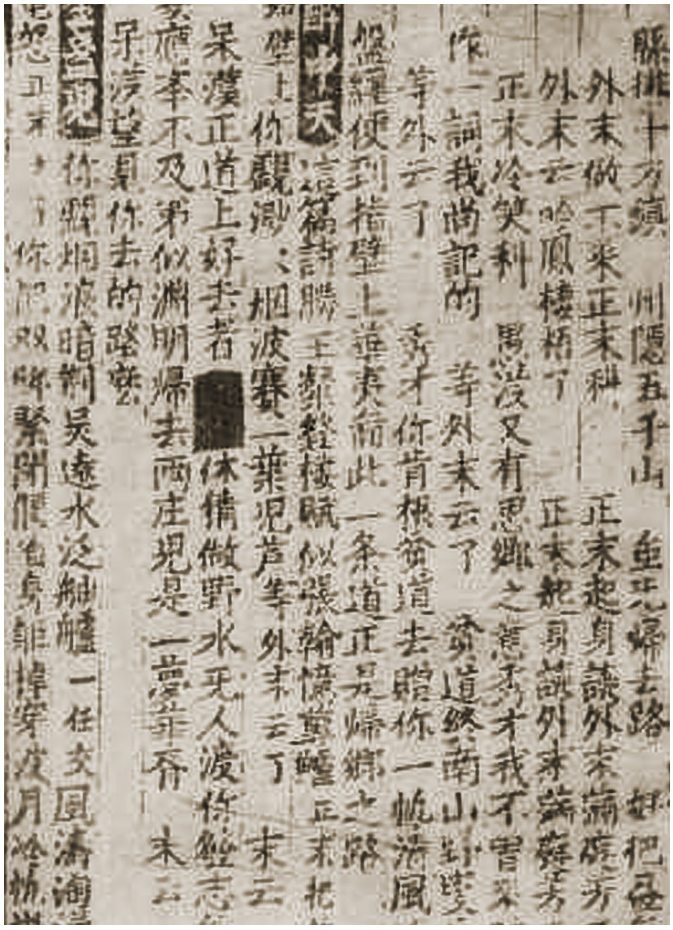
Wood ash, lime, or lye softened the fibers and turned the final product different shades of white. Lye comes from limestone, a mineral found throughout China. Wood ash was simply left over from cook or kiln fires.

The Chinese made ink from soot mixed with animal fat. The main source for soot was burned pinewood, which was plentiful throughout China. People cut woodblocks for printing from fruit trees because the wood was hard. The most popular was the pear tree. Pear trees grew wild across eastern and southern China.

Methods of Making and Using Paper and Printing Materials

Making paper was not difficult but it was time-consuming. Workers put the plant fibers in a small bowl, called a mortar, and pounded them with a tool called a pestle. Then they added water and mulberry bark to the plant fibers and pounded the mixture into a pulp. Next, they poured this pulp onto a piece of

Hemp fibers



Woodblock print

loosely woven cloth, letting the water drain through. They left the fibers on the cloth to dry.

Once the fibers were dry, workers combined them with lime, or ash, and water in a basin. After it soaked for several days, the mixture was gently steamed or boiled for 30 to 40 days in large kilns. Paper-makers usually added small pieces of cloth (made of bamboo or hemp) to this water mixture. They also added juice squeezed from birch or oak leaves. The juice acted like glue and made the paper stronger.

Then, they strained the whole mixture, leaving behind the pulp. Workers floated this pulp above a large screen (usually made of woven bamboo). They pushed the pulp around to make it an even thickness. They drained the water and turned the screen upside down on a felt mat. This released the sheet of "paper." Layers of paper were pressed flat together to squeeze the water out so the paper would dry.

Printing requires ink as well as paper. To make ink, artisans combined soot and animal fat. Soot is the incompletely burned wood or coal that collects in chimneys and ovens. The best soot came from pine or lacquer wood. Later, ink makers collected soot left behind by burning candles. People scraped animal fat from hides and melted it. When they mixed the animal fat with the soot, it acted like glue. The mixture was shaped into solid sticks or cakes. Scraping or dipping the solid ink into water made it usable.

Last, but not least, printing required wood blocks. Printers preferred pear wood for their blocks. Pear wood is smooth, even-textured, and medium hard. It is possible to carve it in any direction. After cutting a piece of pear wood from a tree, the printmakers soaked the wood in water for a month to harden it. After it dried in a shady place, the wood was planed smooth and flat on two sides. This allowed the printer to print two pages using the same block. Finally, the woodblocks were polished with vegetable oil.

By inking the carvings on the sides of the woodblocks and then pressing a piece of paper or cloth against them, the Chinese mass-produced written work that previously had been hand-written. They published hundreds of volumes of literature and philosophy. They also published manuals that described scientific discoveries, industrial processes, farming, and many other useful things.

The Influence of Paper and Printing on Natural Systems

People made the first paper from bamboo. The quality of the paper was excellent, and it was inexpensive to make. It took three tons of bamboo to make one ton of paper. Papermakers harvested bamboo from the wild. They also grew bamboo on farms. To do so, they cleared the forests, which changed the landscape.

Later, the Chinese used hemp fibers to make paper. It took six tons of hemp to make one ton of paper. But hemp grows faster than bamboo. Farmers could harvest it more than once a year. Hemp also made a stronger paper that lasted longer. Hemp farms started popping up all around China.

To prepare the hemp, people left stalks in the fields to rot or soaked them in pools or tanks. Workers often added lye or wood ash to soften the hemp more quickly. Once the hemp was softened, the water was poured out into the nearby rivers or lakes. Lye and wood ash harmed some of the plant and animal life with which it came in contact.

On top of this, making paper takes a lot of water. Papermaking villages dammed the nearby rivers and streams to guarantee the supply of the water they needed. They dug pits in the ground in which to soak the hemp and bamboo stalks. Mines near the village provided the needed lye. As paper became more important to the people of China, these villages became larger and larger, and used more and more of the resources from the surrounding countryside.

Students taking examinations

The Influence of Paper and Printing on Social Systems

Woodblock printing allowed the Chinese to print more books quickly and cheaply. Printers began publishing a lot of books. Calendars were also very popular. Merchants used an internal trade network to distribute these books. People bought them in market towns.

Because printing made books less expensive, more people learned to read and became educated. By the time of the Song Dynasty, many people had improved their social and economic status. The Chinese government began to hire only people who could read and write. It developed a series of local or provincial “examinations” that people were required to take to prove they were educated. If they passed the examinations, they were hired to do government work.

Paper and printing also brought about new forms of writing. Poetry and drama became popular. Scholars also wrote books about philosophy and history, but at the time there were no professions like today’s scientists and historians.

The Chinese also were the first to use paper money. First merchants and then the government began using paper or cloth currency during the Song and Yuan dynasties. Paper was a lot easier and safer to carry than other forms of money.

The Facts About: The Compass and Shipbuilding

Early Chinese compass

Introduction

China's coastline is over 9,000 miles long, so it is not surprising that ships have played an important role in Chinese history. For many centuries, the Chinese developed advanced ships and tools to help them navigate.

The Chinese built boats of all sizes. The smallest carried perhaps one man and two baskets of tea. The largest held hundreds of men and all the supplies they needed for a month at sea. Thousands of years of invention and experimentation led to many advances in ship design and building. During the Song Dynasty, shipbuilders introduced the world's first watertight hulls. Stronger hulls enabled the Chinese to build bigger, seaworthy ships. One of these ships could carry 1,500 tons of cargo.

By the late 1000s CE (Common Era), Chinese ships were the best built, and best equipped ships in the world. Steering a Chinese ship, called a "junk," was easy. The Chinese did not use oars. Instead, they attached a modified

oar, called a rudder, to the stern (rear) of the ship. Rudders made steering a boat or ship easier. Chinese sailors were using them as early as the first century CE.

Chinese sails were made of bamboo. They were made like today's window blinds. Sailors could roll them up and down by pulling a rope. They did not have to climb around in the masts to attach the sails or take them down. In addition, they could open up only as much of the sail as they needed.

Beginning in the 1000s, Chinese sailors used magnetic compasses to sail far from shore. A magnetic compass is made of a magnetized pointer that rotates freely. The pointer aligns itself with Earth's magnetic field and points to the magnetic north and south poles. A compass helps sailors find their way.

The first compasses were very simple. A piece of magnetic ore was floated in a bowl of water on top of a small piece of bamboo. The Chinese used these simple compasses to build their cities, homes, gardens, and tombs according to *Feng shui*. Feng shui is an ancient Chinese system of building human environments in harmony with the four compass directions.

When the Chinese learned to magnetize steel, they made better compasses. Large, permanently-mounted compasses were common on Chinese ships by the late 1000s. Ships could then sail far from shore without getting lost.

Resources Used in the Compass and Shipbuilding and Where They Came From

Early magnetic compasses were made of simple resources. Boxes, bowls, water, and bamboo came from local sources. Some compasses were made with gold and brass (a mixture of copper and zinc). But the most important ingredient was the piece of lodestone. Lodestone is a common iron ore called magnetite. The Chinese found large deposits of magnetite in the northern provinces of Jilin, Liaoning, Hebei, Shanxi, Shaanxi, Gansu, and Xinjiang. Over time, steel replaced lodestone in compasses. Steel came from the iron ore in central and eastern China, in the lower Yangzi Valley, especially in the Sichuan, Hubei, and Anhui provinces.

To build ships, the Chinese needed lots of wood. They used pine, fir, and larch. These types of trees grew in the mountain forests of the western China. For masts, shipbuilders used the trunks of camphor trees. Camphor is a large tree that, when mature, has a trunk that is very tall and straight. Recently, a 2,000-year old camphor tree was discovered in Jiangxi province with a trunk that is 75 feet around and almost 200 feet tall. Camphor trees grew naturally on the island of Taiwan (Formosa) and on the mainland in southeastern China. They also grew in Hunan and Fujian provinces.

Bamboo was another resource used in shipbuilding. All sails on Chinese ships used bamboo frames to support the sails. Bamboo grew almost everywhere in southern China.

Elm or langmu wood was known to be the best for making rudders. The junk's rudder was often the strongest part, steering the ship in all kinds of ocean conditions.

Methods of Making and Using the Compass and Ships

All compasses need a magnet. Originally, compass makers simply collected lodestone from the ground. Lodestone is naturally

Camphor tree

magnetic. With a bowl of water, something magnetic, and a flat piece of bamboo 2 or 3 inches long, you can make a compass that points north and south.

In the 11th century, a member of the Chinese court discovered that rubbing steel needles with a piece of lodestone would magnetize the needles. Hanging a magnetized needle on a strand of silk thread or floating it in water made a small, lightweight compass.

To make steel, you need iron. First, you dig iron ore out of the ground. Then you heat it in a furnace to a very high temperature. The iron melts and separates from the rock. Air is then blown across the liquid iron and charcoal is added. The carbon in the charcoal forms a stronger metal, known as steel. As the steel cools, it is poured into molds or hammered into shapes, like needles. Steel and iron were also used to make the nails that held Chinese junks together.

A Chinese junk was built in several parts. The wood used for ship construction was cut and milled where it grew. Then, on large bamboo rafts, the wood was sent east on rivers to the major shipyards on the Chinese coast. There, it was cut and shaped into the pieces for each part of the ship.

The sails were made by stretching fabric between a series of parallel bamboo “battens.” A batten is a flat strip of wood or metal used to hold something in place. To make a sail, the battens were sewn onto one side of a sheet of bamboo.

The rudder was made separately and placed on the ship in the last stages of construction.

The Influence of the Compass and Shipping on Natural Systems

The main raw material for shipbuilding in medieval times was, of course, wood. The Chinese first harvested trees from the mountains close to the coast, but eventually they had to cut trees from the western and southern mountains and transport them to the shipbuilding centers.

Harvesting bamboo and cutting trees changed local environments. Chinese farmers cleared land to grow bamboo. They cut down trees, removed other plants, and drained wetlands. They disrupted nesting and feeding grounds of birds and small mammals. There were also other demands for wood in China. People needed fuel, for example. All of these demands led to the deforestation of many parts of the countryside.

Making compasses and building ships also required minerals that had to be mined. To mine iron, lodestone, copper, and tin, the Chinese dug pits and tunnels. They removed trees and vegetation around the mines. The foundries that processed the ore had furnaces that burned a lot of wood or coal, day and night. The furnaces gave off lots of smoke and ash. Melting ores released other gases. The hot and toxic waste products, called slag, were dumped into nearby pits or into the local rivers and streams.

In addition to these effects on natural systems, the Chinese shipping industry also changed China's rivers forever. During the Sui Dynasty (589–618 CE), the Grand Canal was built. The Grand Canal is a thousand miles long. It runs from Xian in the north to Hangzhou in the south and connects all the naturally flowing rivers in China that run west to east. Thousands of workers deepened and widened the rivers and drained swamps and lakes in and around the canal. This changed China's natural systems, by affecting native plants and animals, and the rivers' flow.

The Influence of the Compass and Shipbuilding on Social Systems

Shipbuilding was a huge business that employed thousands of workers. Some workers cut trees, milled lumber, and transported it to shipyards. Some worked at the yards building the ships. Others loaded and unloaded cargo. Still others made sails, ropes, compasses, and nails. The Chinese government built, paid for, and controlled almost all shipping.

Before the Song Dynasty (960–1279 CE), Chinese ships traveled mostly on the inland rivers. Barges and small flat-bottomed boats brought goods to market and tributes to the emperor. Then a major change took place. In the 1100s, people from the north invaded China. They drove the Song emperor out. The Song emperor built a new capital at Hangzhou. The emperor ordered workers to build a huge fleet of warships to defend China from invasion. This became the first official Chinese navy, with a fleet of about seven hundred ships.

One Ming emperor decided to show the world how powerful China was. He ordered his admiral, Zheng He, on a series of seven voyages. More than 300 ships made the first voyage, carrying almost 20,000 men.

Between 1405 and 1433, Zheng He and his fleet traveled the Indian Ocean and landed in East Africa. The crews used compasses to navigate large stretches of open sea. Zheng He's fleet eventually had 1,600 ships—compared to the four ships in Columbus's fleet decades later. They opened new sea routes and promoted the exchange of culture and trade among the people of the world.

The Facts About: Iron and Steel

Foundry

Introduction

Three thousand years ago, the Chinese figured out how to get iron from iron ore. China's Iron Age had begun. Up until that time, people mined copper and tin, and combined them to make bronze.

But iron was better in many ways. It is much harder than copper or tin. It occurs naturally and is easier to find. Further, iron tools and weapons can be sharpened more effectively than those made of other metals. And with iron, people could make better agricultural tools, which led to greater farm productivity. These gains in productivity contributed to the growth of the human population.

Working with metal is called "forging." Metal is forged in a "foundry." People make two kinds of iron goods: cast iron or wrought iron. When pure iron is melted and poured into a mold with a particular shape, you get cast iron. If you heat iron just until it becomes soft, then hammer, bend, or twist it into a shape, you get wrought iron. Steel is an alloy (mixture) of iron and carbon. Steel products are made both ways—using molds (cast) or by hammering, bending, or twisting it into shape (wrought).

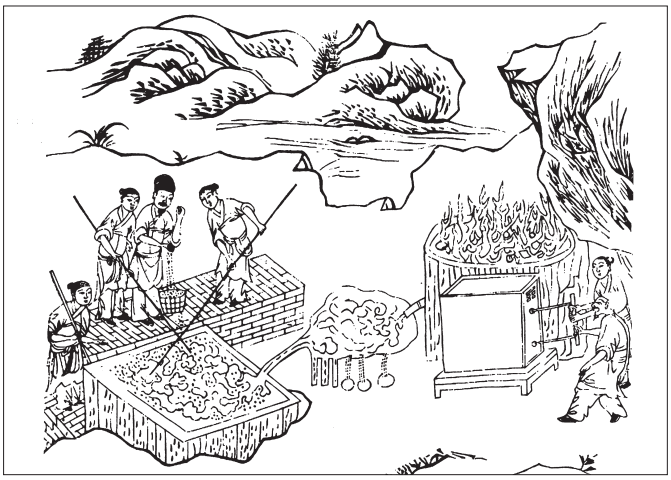
The Chinese were making cast iron tools as early as the 6th century BCE (Before the Common Era). They mostly used these tools for farming (hoes, plows, wheelbarrows, and seed drills) and cooking. By 120 BCE, the Chinese began making steel. They wore steel armor and used weapons of cast and wrought iron.

In contrast, Europeans did not make cast iron until at least the 1300s CE. North China was producing about 114,000 tons of iron a year in 1078 CE. By comparison, 700 years later, England was producing only about 50,000 tons.

Resources Used in Iron and Steel and Where They Came From

Making iron and steel requires a source of iron ore. Hematite and magnetite are common iron-bearing ores. Iron makers found large deposits of both minerals stretching across northern China in Heilongjiang, Jilin, Liaoning, Hebei, Shanxi, Shaanxi, Gansu, and Xinjiang provinces. In central and eastern China, they found iron ore mostly in the lower Yangzi Valley, especially in Sichuan, Hubei, Anhui, Henan, Shandong, and Jiangsu provinces. They found high grades of iron in southern China, too, especially in Guangxi, Guangdong, Fujian, and Jiangxi provinces.

Making iron and steel also requires fuel for the fire to melt the metal. Fuels were plentiful in China. Originally, people gathered and burned wood and bamboo from forests all across China. Later, they began to use charcoal instead. To make charcoal, the Chinese burned large piles of wood without air. By the 4th century CE, the Chinese had begun using coal in iron and steel production. Large coal deposits existed in northern China, most notably in Shanxi, Shaanxi, Henan, and parts of Anhui provinces.



Smelting iron

The Chinese also discovered that by adding some materials to the fire, they could melt iron at lower temperatures. This kind of material is called a “flux.” The Chinese used saltpeter (potassium nitrate) as a flux in making iron. Saltpeter occurred naturally. People found it crystallizing on cave walls, in dried sea and lakebeds, and in manure.

As foundries grew larger, the furnaces where the fuels burned were lined with clay to absorb the great heat produced there. Clay was found in and around the rivers in China.

Methods of Making and Using Iron and Steel

Iron ore is mined from veins underground. Miners dug tunnels into the earth by hand. They lined the tunnels with wooden planks and beams to keep them from falling in on the miners. Workers used hammers and picks to break the ore from the mine walls. Then they loaded it into wheelbarrows and carried it up to the surface.

Iron ore was also collected from rivers and streams. Workers dug up the sand from the river bottom. Then, they separated the iron ore from the sand using sluice boxes, just like gold miners did in California—only 3,000 years earlier! The ore was collected in wooden boxes or cloth bags.

Once the ore was mined, it was taken to a nearby foundry. The ore was heated in a furnace

until the iron melted and separated from the other material in the ore. The melted iron was then poured into a mold. The waste material left in the furnace, called "slag," was thrown away.

Then several things happened. To make cast iron products, the pure iron went to a different foundry where it was melted again and poured into molds to make products like pots, plows, and drills. For wrought iron products, the pure iron went to a foundry where it was softened and stirred in big vats until it was the right consistency. Then ironworkers beat it with hammers into the shapes they needed.

By at least 120 BCE, the Chinese had discovered another interesting thing about iron: If you blew air across melting iron, it became hotter. If you added charcoal at this point, it melted and mixed into the iron. The resulting metal made stronger tools. The new metal was more flexible than cast iron. It could bend without breaking. It also held a sharp edge over time. This material was steel. The Chinese invented a "double-pump bellows" to provide a constant supply of air to the steel furnaces. They used waterwheels turned by river water to work the bellows.

The Influence of Iron and Steel on Natural Systems

China had a lot of iron. In some places, it lay underground. In others, it was mixed in with sand or clay.

No matter where they found the iron, people had to dig it out. That meant moving a lot of earth and rock. The Chinese used hand tools to dig into the sides of mountains. The rock and dirt they did not want, they tossed into big piles called "tailings." The mines produced huge piles of tailings.

Wood, from trees, was also important in making iron and steel. Wooden beams and poles, cut from nearby forests, supported the ceilings of mines. Wood was also used in the furnaces or to make charcoal to use in the furnaces. By the time of the Song Dynasty, many parts of China had been deforested in order to support iron and steel production.

Foundries were almost always built next to a stream or river. The moving water, sometimes dammed and diverted, turned waterwheels to help produce the iron. This changed the flow and ecosystem of the river or stream.

Wood and charcoal were the earliest fuels used in the foundry furnaces. Later, coal was used. Burning coal, wood, and charcoal releases smoke, ash, and other gases. Foundries were built with many openings that allowed the gases to escape so they would not build up to dangerous levels inside the buildings. But the gases went out into the atmosphere.

The other effect that iron and steel had on natural systems came through their use. Plows and hoes made of iron and steel were more effective in digging up earth. Other tools made of iron and steel made it easier for humans to change their surroundings. The population increase that resulted put more strain on natural systems.

The Influence of Iron and Steel on Social Systems

The iron and steel industry expanded rapidly during the Song Dynasty (920–1279 CE). Iron production increased twelve times between 850 and 1050. The Chinese government controlled these industries. It ordered the mass-production of agricultural tools (hoes, plows, seed drills) and promoted their use.

Metal armor

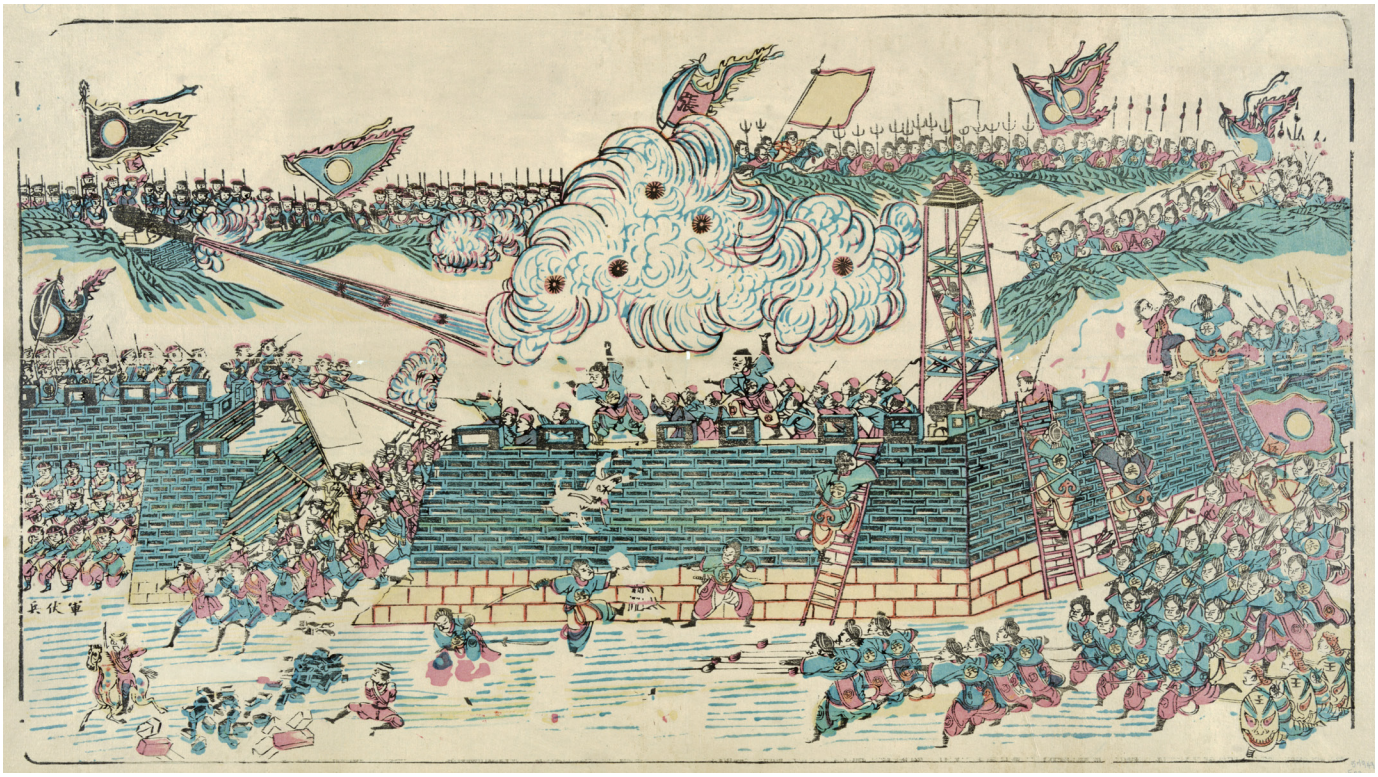
Government-owned iron and coal mines employed a lot of workers. An iron mine in Heilongjiang province during the Song Dynasty employed over 1,000 men. Slaves and conscripted workers also worked at the mines. A conscripted worker was a person who owed the government a debt. They worked to pay off their debt.

Iron and steel improved the life of ordinary Chinese people. The widespread use of iron farming tools, supported by government, increased grain production. The government helped store and distribute the harvest. It bought grain when there was a surplus and sold it when there was a shortage. This helped control the food supply and stabilize prices. Cities grew and the population of China doubled between the 12th and 13th centuries.

Other products changed Chinese life, too. Cast iron and steel wheelbarrows were common forms of transportation. The salt industry used iron drill bits to get to underground brine (salty water). Then, they boiled the brine in large cast iron pans to separate out the salt. In looking for salt water, the Chinese discovered natural gas. They used it to heat the saltwater. Although not on any large scale, the Chinese used bamboo pipes to transport natural gas for heating and light.

The invention of iron and steel also changed the Chinese military. Innovative suits of armor gave Chinese warriors an advantage over their opponents. Eventually, iron and steel were used to make guns, cannons, rockets, and bombs, changing warfare forever.

The Facts About: Gunpowder



Chinese battle

Introduction

The western world first learned about gunpowder in the early 1200s. By that time, China had already perfected the use of guns and cannons.

Three main minerals used by iron-makers and potters turned out to be the key ingredients in gunpowder. They were saltpeter (potassium nitrate), carbon, and sulfur. When alchemists (the chemists of their day) combined these three ingredients and lit the mixture, it exploded. The sulfur caught fire. Carbon kept the fire burning. Saltpeter created the explosion. The more saltpeter in the mixture, the more explosive it was.

In about 400 CE (Common Era), people began to pack small quantities of saltpeter and sulfur into hollow bamboo stalks. When they threw the packed stalks in the fire, a loud sound was created. By adding other chemicals, color became part of the explosion. These were the first fireworks.

Over time, the Chinese made more powerful mixtures of gunpowder. By the 1200s, they were manufacturing many weapons powered by gunpowder. These included rifles, cannons, bombs, and rockets. The discovery of gunpowder eventually changed the nature of war and the balance of world power. At the time, however, bows,

arrows, and other basic weapons remained the major tools of war.

Resources Used in Gunpowder and Where They Came From

Saltpeter is one of the main ingredients in gunpowder. Saltpeter is a chemical compound called potassium nitrate. It forms when decaying matter interacts with air, water, and alkalis. This occurs naturally in areas that are rich in plant and animal life. Saltpeter looks like a thin white powder, or salt. An Arab trader once described it as "Chinese snow." It could look like snow when it was found above ground. Saltpeter also forms in layers underground and crystallizes on cave walls. Shanxi, Henan, and Hebei provinces in northern China were rich sources for saltpeter. So were the caves in the mountains of Yunnan and Sichuan.

Sulfur is another ingredient needed to make gunpowder. Sulfur is a yellowish mineral that forms layered deposits in the earth. The Chinese found sulfur in areas with volcanic activity or hot springs, and, later, in coal mines. One area with large deposits of sulfur was southern Shaanxi province. Other provinces with smaller deposits included Shanxi, Gansu, and Xinjiang.

Saltpeter

Carbon is the third major gunpowder ingredient. Carbon exists in all organic material, so almost anything that is alive—or that has been alive—can be a source. Once the Chinese began large-scale production of gunpowder, the best source for carbon was charcoal. Charcoal is mass-produced by burning large amounts of wood without much air. This is done by igniting a big pile of wood and burying it in dirt or clay, leaving a small hole at the top for steam to escape. After several days of burning, only the carbon in the wood remains.

Methods of Making and Using Gunpowder

When saltpeter was found above ground, the Chinese simply scraped it from the soil or off cave walls. If it was underground, they dug mines. As the importance of gunpowder increased, the demand for saltpeter outgrew the natural supply. People discovered that if they collected organic waste in large mounds and allowed it to sit undisturbed, saltpeter would form on the piles. They began to build saltpeter "plantations."

Once the saltpeter was collected, water was poured over it. Then some wood ash or lime was added, and the mixture was filtered. The remaining water was boiled off, leaving behind a layer of fine white crystals.

Like saltpeter, sulfur was collected and then processed. Rocks and soil containing sulfur were stacked in a brick oven at the top of a hill. Previously powdered sulfur was sprinkled on top of the pile. Then the pile was set on fire. The sulfur separated and flowed down the

hillside, where it was collected in buckets. After it dried, it was ground into a powder.

Charcoal was also ground into powder. Workers mixed sulfur and charcoal with saltpeter in careful proportions, avoiding too much heat and mixing to prevent an explosion.

Over time, the Chinese experimented with different amounts of the three ingredients. When they increased the amount of saltpeter in the mixture, the Chinese produced a real explosion. They found that they could better control the explosion if it occurred in a narrow tube or barrel. At first, they made these tubes from bamboo. Archers attached bamboo tubes filled with gunpowder to their arrows. They used these "rocket arrows" against "barbarian" invaders in 1126 CE. Soon, they discovered that the power of escaping gas propelled these gunpowder-packed tubes, so they no longer needed bows. These were the first rockets.

Before long, they started using iron and steel to make cannons and guns. Soldiers also learned to use gunpowder for flamethrowers and to ignite poison-filled bombs. Landmines, grenades, and other firearms followed. As their technology improved, the Chinese began mass-producing weapons.

The Influence of Gunpowder on Natural Systems

To make gunpowder and weapons, people had to take raw materials from the ground. In Henan province alone, people removed 30,000 pounds of saltpeter per acre. To do this, they simply stripped the entire layer of minerals from below the surface. They also removed all the soil, rocks, and plant life on the surface. If they dug saltpeter from layers inside the earth, the holes were deeper. They piled up the extra materials, called "tailings," near the mines. The tailings buried additional habitat and washed into the rivers and streams when it rained.

As the Chinese began to make saltpeter, they built huge artificial mounds of human, animal, and vegetable waste. These concentrated "collections" affected the air, soil, and water nearby.

Refining saltpeter required a lot of water. In some places, people carried it in buckets from creeks, streams, or ponds to the factories. In other places, dams, ditches, or human-made channels diverted the flow of water from a creek or stream to the factory. This modified entire wetland and river ecosystems.

The Chinese used wood for many things, including making charcoal. They used so much wood that by the middle of the Song Dynasty, many parts of China were deforested. Deforestation led to increased erosion and flooding. With fewer trees available, people began to use coal as a source of heat. Burning coal, charcoal, and sulfur emits dangerous gases, smoke, and ash into the air. The waste products from burning the sulfur ore, called "slag," were dumped into pits near the hilltop ovens. This waste washed down the mountains and into rivers and streams when it rained.

The weapons that used gunpowder also affected natural systems. Large Chinese armies went into battle armed with bows, arrows, spears, flamethrowers, bombs, rockets, cannons, and rifles. Battles often took place in the countryside around cities and towns. These weapons caused terrible destruction of the land and living things.

The Influence of Gunpowder on Social Systems

Emperors of the Song Dynasty were engaged in an almost constant war with the Jin people from the north. To fend them off—which they succeeded in doing for 300 years—the Song emperors formed and armed a permanent navy. So, they also had an army of over a million men.

Song officials understood the military advantage that gunpowder provided. So, they tried to keep the process for making gunpowder a secret. They threatened death to anyone who shared it with others. They also tried to control gunpowder making. In 1067, the emperor stopped the sale of saltpeter and sulfur to foreigners. By 1076, he extended the ban to all internal trade. This put all private gunpowder makers out of business. It gave the government total control of the gunpowder and weapons industries.

The Song emperors tried to gain control of the iron industry the same way. But they were not as successful, because the iron industry was already too well established and too spread out. Still, the Song emperors managed to produce 125,000 tons of iron and steel in their own factories. They also bought iron and steel from private companies.

Centuries of using wood for cooking, heating, other household needs, and especially for making charcoal for the iron and steel industry, placed great demands on China's forests. But the need for carbon to make gunpowder was too great. It threatened to limit the amount of both iron and gunpowder that China could make.

Song officials made an important decision. They required all government-owned factories to burn coal instead of wood or charcoal. This decision had many effects. First, it meant that more trees could be set aside and used only to build naval warships and to produce the charcoal needed for gunpowder. It also caused the rapid expansion of the coal and natural gas industries.

The written Chinese language is not phonetic like English. A process called "English romanization," is used to help English speakers pronounce Chinese and other foreign words. This process involves using the Roman (Latin) alphabet, as we do in English, to represent words from a different language. Over the centuries, there have been many different systems of romanization. "Pinyin" romanization is now used almost universally and is the "official" romanization of Chinese.

Use this list to help you find places on the **China's Natural Regions** poster if the name on the map and in **The Facts About: _____** (Student Edition, pages 6–26) is not the same.

Pinyin Spellings	Postal Spellings
Ānhuī	Anhwei
Beijing	Peking
Chongqing	Ch'ung-ch'ing or Chungking
Fújiàn	Fukien
Gānsù	Kansu
Guangxi Zhuang	Kwangsi
Guǎngdōng	Kwangtung
Gùizhōu	Kweichow
Hǎinán	Hainan
Héběi	Hopeh
Hēilóngjiāng	Heilungkiang
Hénán	Honan
Hubei	Hupeh
Húběi	Hupeh
Húnán	Hunan
Jiāngsū	Kiangsu
Jiāngxī	Kiangsi
Jílín	Kirin
Liáoníng	Fengtien
Mongol	Nei Mongol
Qīnghǎi	Tsinghai
Shǎnxī	Shensi
Shāndōng	Shantung
Shanghai	Shanghai
Shānxī	Shansi
Sìchuān	Szechuan
Táiwān	Taiwan Formosa
Tianjin	Tientsin
Yúnnán	Yunnan
Xinjiang Uyghur	Sinkiang
Zhèjiāng	Chekiang

Forest

- Conifer
- Conifer (with deciduous and broadleaf evergreen)
- Conifer (mainly spruce) and steppe grass
- Mixed conifer and broadleaf deciduous
- Broadleaf deciduous
- Mixed broadleaf deciduous and evergreen
- Broadleaf evergreen
- Broadleaf evergreen (monsoon rainforest)

Grasses Dominant

- Steppe grass
- Alpine grass (some conifer and shrubs)

Vegetation Sparse or Lacking

- Drought and salt-tolerant grasses and shrubs
- Alpine and drought-resistant plants

Timeline of Chinese Dynasties		
Ancient China	Neolithic ca. 12000–2000 BCE	
	Xia ca. 2100–1800 BCE	
	Shang 1700–1027 BCE	
	Western Zhou 1027–771 BCE	
	Eastern Zhou 770–221 BCE	Spring and Autumn period 770–476 BCE Warring States period 475–221 BCE
Early Imperial China	Qin 221–207 BCE	
	Western Han 206 BCE–9 CE	
	Hsing (Wang Mang interregnum) 9–25 CE	
	Eastern Han 25–220 CE	
	Three Kingdoms 220–265 CE	
	Western Chin 265–316 CE	
	Eastern Chin 317–420 CE	
	Southern and Northern Dynasties 420–588 CE	**Southern Dynasties** Song 420–478 Qi 479–501 Liang 502–556 Chen 557–588
		Northern Dynasties Eastern Wei 534–549 Western Wei 535–557 Northern Qi 550–577 Northern Zhou 557–588

Timeline of Chinese Dynasties		
Classical Imperial China	Sui 580–618 CE	
	T'ang 618–907 CE	
	Five Dynasties 907–960 CE	Later Liang 907–923 Later Tang 923–936 Later Jin 936–946 Later Han 947–950 Later Zhou 951–960
	Ten Kingdoms 907–979 CE	
	Song 960–1279 CE	Northern Song 960–1125 Southern Song 1127–1279
	Liao 916–1125 CE	
	Western Xia 1038–1227 CE	
	Jin 1115–1234 CE	
Later Imperial China	Yuan 1279–1368 CE	
	Ming 1368–1644 CE	
	Qing 1644–1911 CE	

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