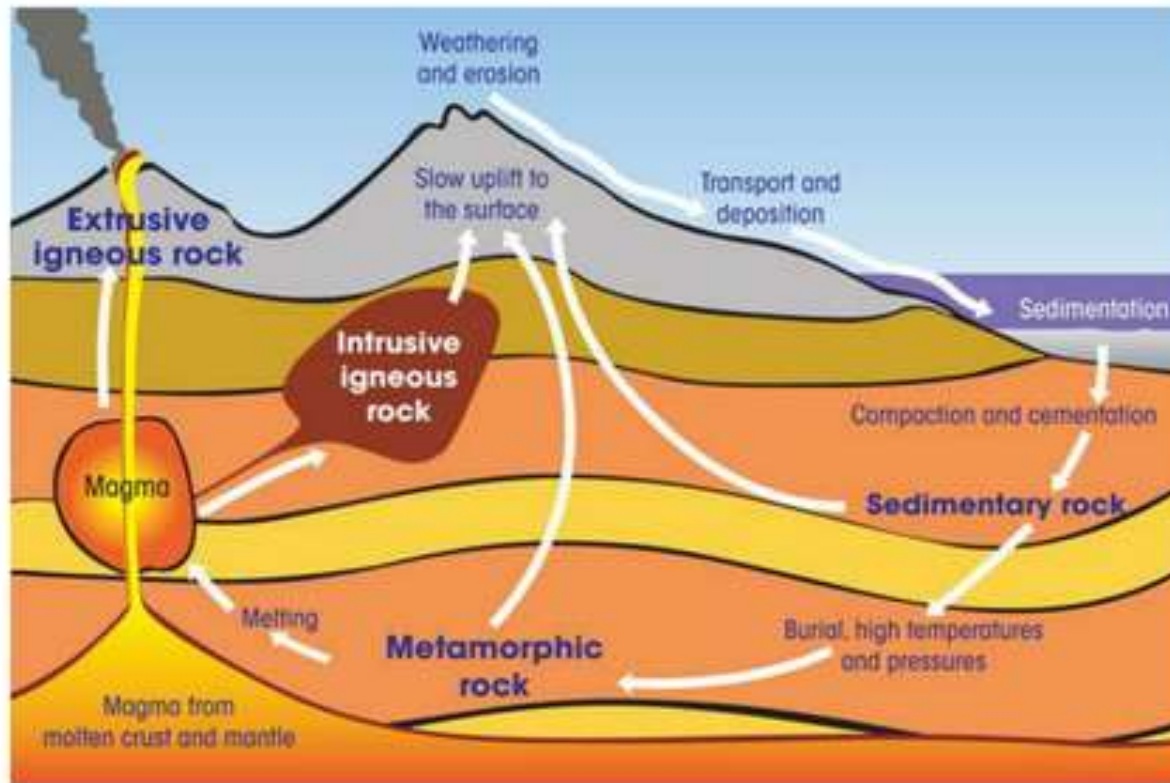


Introduction to Aggregate

Rock Cycle



<https://www.tes.com/teaching-resource/the-rock-cycle-power-point-6118894>

Geologic Origins

Igneous Rocks

Granite
(Intrusive)

Basalt
(Extrusive)

Sedimentary Rocks

Limestone
(Calcium Carbonate)

Shale
(Clay)

Sandstone
(Quartz)

Gypsum
(Calcium Sulphate)

Metamorphic Rocks

Marble
(Limestone)

Slate
(Shale)

Quartzite
(Sandstone)

Gneiss
(Granite)

Natural Sand and Gravel

Sand and gravel are natural deposits of unconsolidated particles found on beaches or in river and stream beds. They are mostly quartz (SiO_2) grains that result from the weathering of rocks such as granite. In the process of weathering, the softer, weaker minerals (such as feldspar) are weathered away and eventually become clay deposits.

Sand and gravel are typically mined in a moist or wet condition by open pit excavation or by dredging. Open pit excavation is carried out with power shovels, draglines, front end loaders, and bucket wheel excavators.

Sand and Gravel Quarry



Gravel

(note the rounded particles)



Crushed Stone

Crushed stone is produced by mining a suitable rock deposit (usually by blasting) then breaking the mined rock down to the desired size using crushers.

Limestone, dolomite, granite and trap rock are the most common types of rock used to produce **crushed stone**.

Because it is angular, **crushed stone** is the key material for asphalt road construction, which depends on the interlocking of the stones' angular faces for its strength.

Stone Quarry



Stone Crushing



Crushed Stone

(note the angular particles)



Gravel vs Crushed Stone

Gravel



(rounded particles)

Crushed Stone



(angular particles)

Blast Furnace Slag

To produce iron, iron ore and a flux such as limestone are charged into a blast furnace along with coke for fuel. The coke combustion reduces the iron ore to molten iron. **Blast furnace slag** is the non-metallic co-product produced in the process. It consists primarily of silicates, aluminosilicates, and calcium-alumina-silicates.

Different methods of cooling the molten slag produces a variety of products such as air-cooled slag, expanded slag, pelletized slag, and granulated blast furnace slag.

Blast Furnace Slag

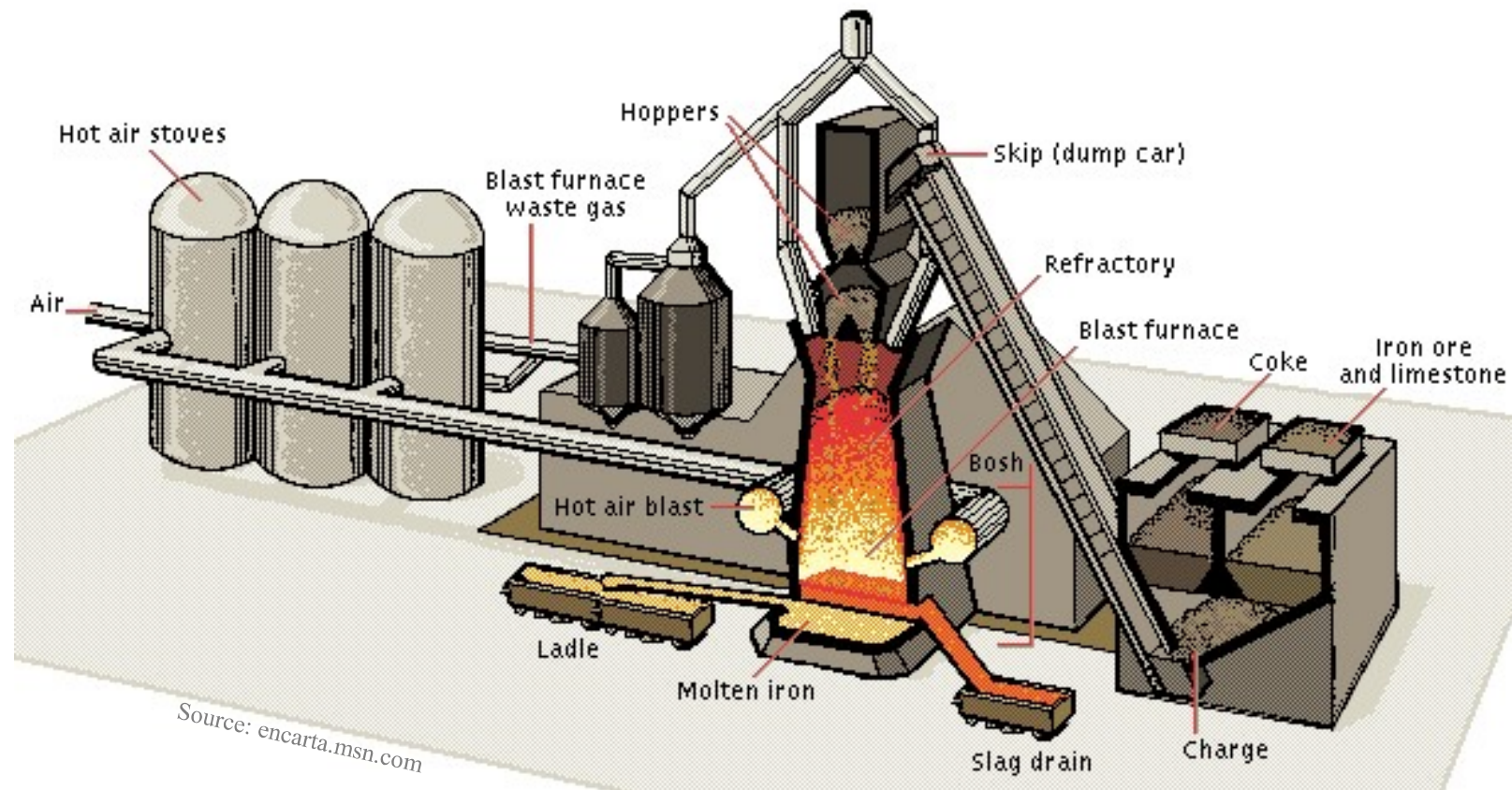
If the molten slag is slowly **air-cooled** a hard crystalline lump slag is produced, which can subsequently be crushed to produce aggregate.

If the molten slag is more rapidly cooled by adding large quantities of water, air, or steam, it produces a lightweight **expanded** aggregate.

If the molten slag is cooled with water and air-quenched in a spinning drum, **pellets**, rather than a solid mass, are formed. These can be used as aggregate or ground into a cementitious material depending on how quickly they are quenched (i.e., how crystalline or glassy they are).

If the molten slag is cooled by rapid water quenching it forms glassy sand-sized **granules** that can be ground into a cementitious material.

Typical Blast Furnace

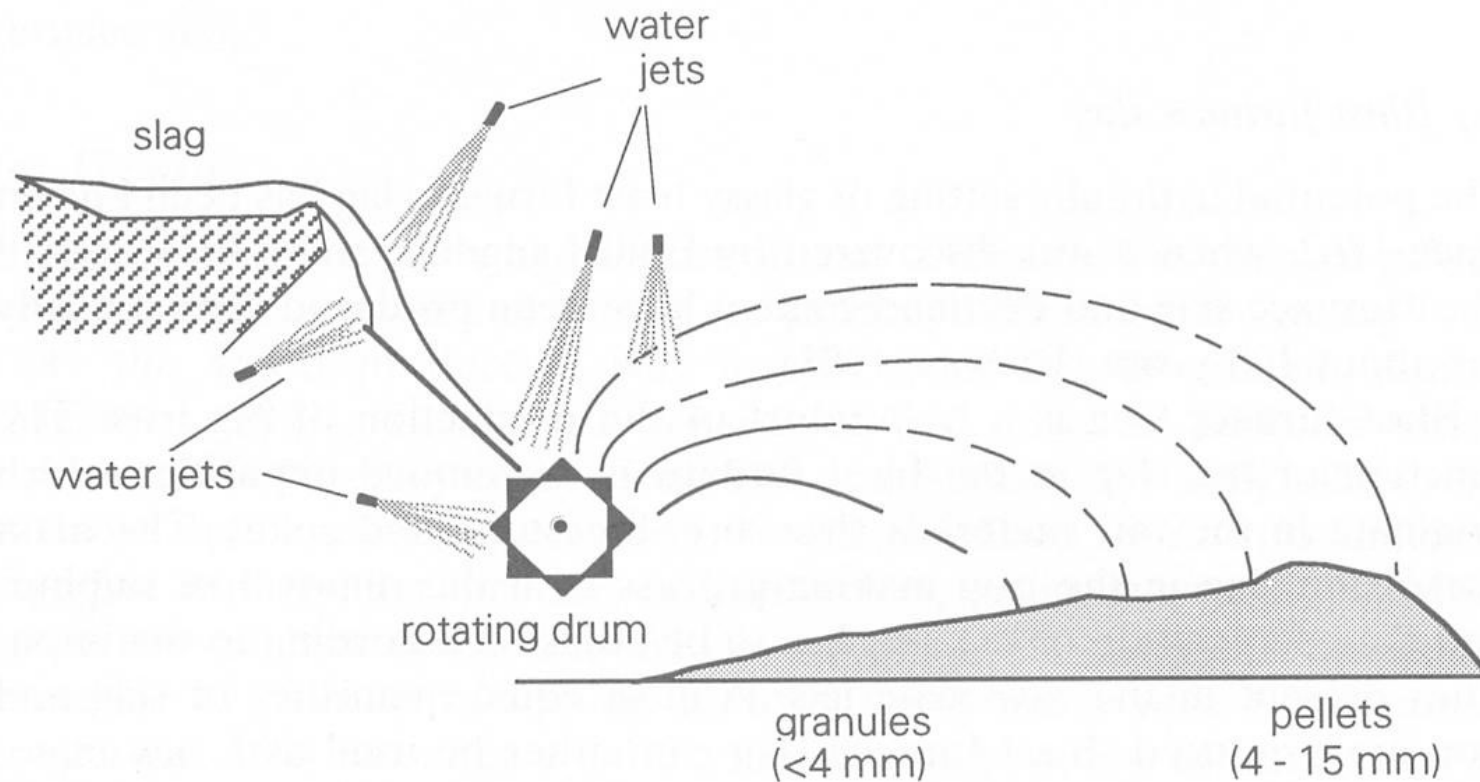


Expanded Slag

(lightweight aggregate)



Granulating Slag



Granulated Slag

(lightweight aggregate)



GGBFS

(cementitious material)



Expanded Shale/Clay/Slate

Expanded shale, clay and slate (ESCS) is a lightweight ceramic material prepared by expanding and vitrifying aluminosilicate minerals in a rotary kiln at temperatures over 1000°C. The process produces a ceramic aggregate that is strong, durable, inert, low in density and insulative.

The low density results from a cellular pore system. At the high kiln temperatures, gases are produced within the pyroplastic mass, causing expansion that is retained upon cooling.

Expanded Shale/Clay/Slate

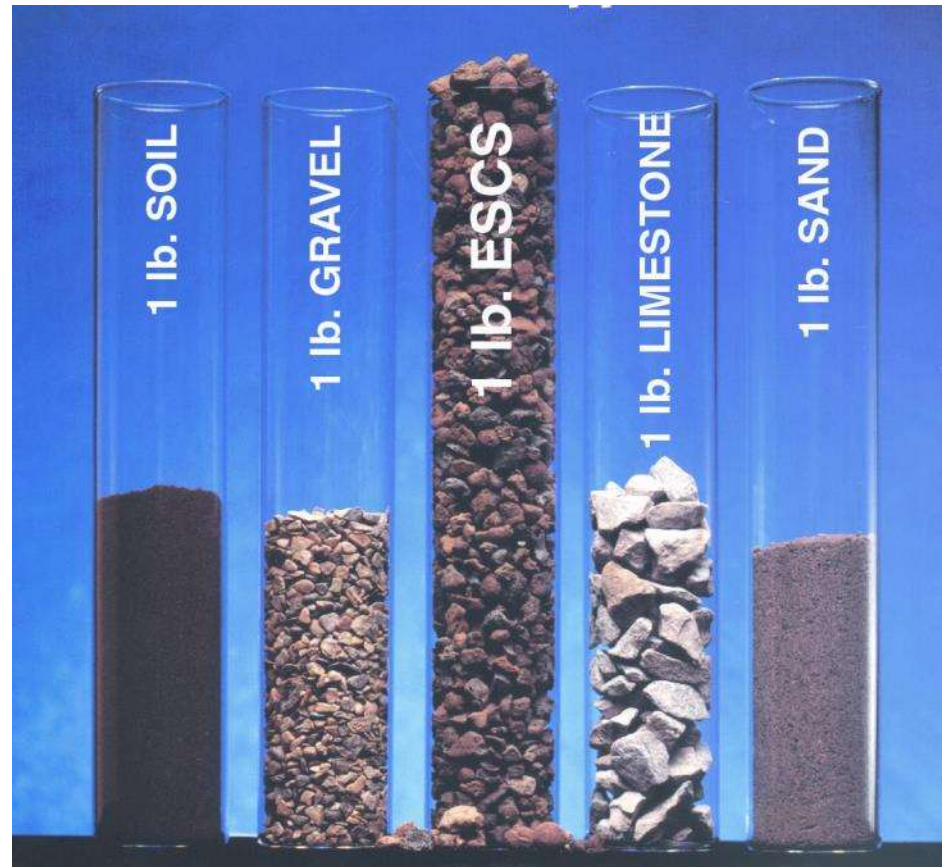
(lightweight aggregate)



Expanded Shale/Clay/Slate



Expanded Shale/Clay/Slate



Crushed Concrete Aggregate

Crushed concrete aggregates are fragments and pieces of concrete structures that have been demolished or rebuilt.

Concrete collected from demolition sites is put through a crushing machine and crushed to specific sizes much like crushed stone. Metals such as rebar are removed in the process and melted down for recycling elsewhere.

Crushed concrete aggregate can be used in the same way as crushed stone and can even be incorporated into new portland cement concrete.

Crushed Concrete



Recycled Asphalt Product

Recycled asphalt product (RAP) results when asphalt pavements are milled to remove the asphalt concrete surface for reconstruction, resurfacing, or to obtain access to buried utilities.

When properly crushed and screened into different sizes, RAP can be used as an aggregate or to manufacture new asphalt concrete. This keeps the old asphalt concrete out of landfills and reduces the amount of virgin asphalt cement needed to make the new asphalt concrete.

Recycled Asphalt Product



Crumb Rubber

Crumb rubber is recycled rubber produced from scrap tires. During the recycling process, steel and tire cord are removed, leaving tire rubber with a granular consistency.

The crumbs can be used in artificial turf as a cushioning material, as a playground surfacing material, or it can be blended into asphalt to make a noise-reducing pavement material called rubberized asphalt.

Crumb Rubber

(discarded tires)



Waste Glass Aggregate

Waste Glass Aggregate consists of recycled or scrap glass that is crushed into a pebble-sized or sand-sized aggregate particles. It has many of the same properties as the natural sand from which it was originally made.

Crushed glass is often used in concrete countertops because of its variety of colors. It can also be used to replace some or all of the sand in conventional portland cement concrete and mortar.

Waste Glass Aggregate

(recycled glass)



Glass Aggregate Concrete



Aggregate Terms

Fine aggregate (“sand”)

Aggregate particles that are smaller than 4.75 mm or 3/16" and largely free of fines

Coarse aggregate (“gravel”)

Aggregate particles that are larger than 4.75 mm or 3/16" and typically free of cobbles and boulders

Aggregate Terms

Pit run sand / gravel

Aggregate taken from a sand or gravel pit with little or no processing. Also called bank-run sand/gravel.

Crusher run gravel

Pit gravel that has been run through a crusher to reduce the particle size and/or provide particles with flat (cleaved) faces so they interlock better.

Aggregate Terms

Crushed stone (crushed rock)

Coarse aggregate produced by crushing bedrock. Unlike gravel, which is rounded, the particles are angular with flat faces and sharp edges.

Screenings

The stone chips and dust produced by the crushing of stone for coarse aggregate.

Aggregate Terms

Manufactured Sand

Fine aggregate produced by crushing bedrock. Unlike natural sand, which is rounded, the particles are angular with flat faces and sharp edges.

Concrete sand

Sand that has been washed to remove dust and fines (not to mention sticks, twigs, leaves, etc.).

Aggregate Terms

Fines

Silt, clay, or dust particles smaller than $75\text{ }\mu\text{m}$ (a No. 200 sieve) that are usually considered undesirable impurities in aggregate

Mineral filler

A finely pulverized inert mineral or rock that is used to impart certain useful properties, such as hardness, smoothness, or strength.

Important Properties

Gradation

Relative density and absorption

Hardness (resistance to wear)

Durability (resistance to weathering)

Shape and surface texture

Deleterious substances

Crushing strength

Soft and lightweight particles