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Types of Rocks: Igneous, Sedimentary, and Metamorphic

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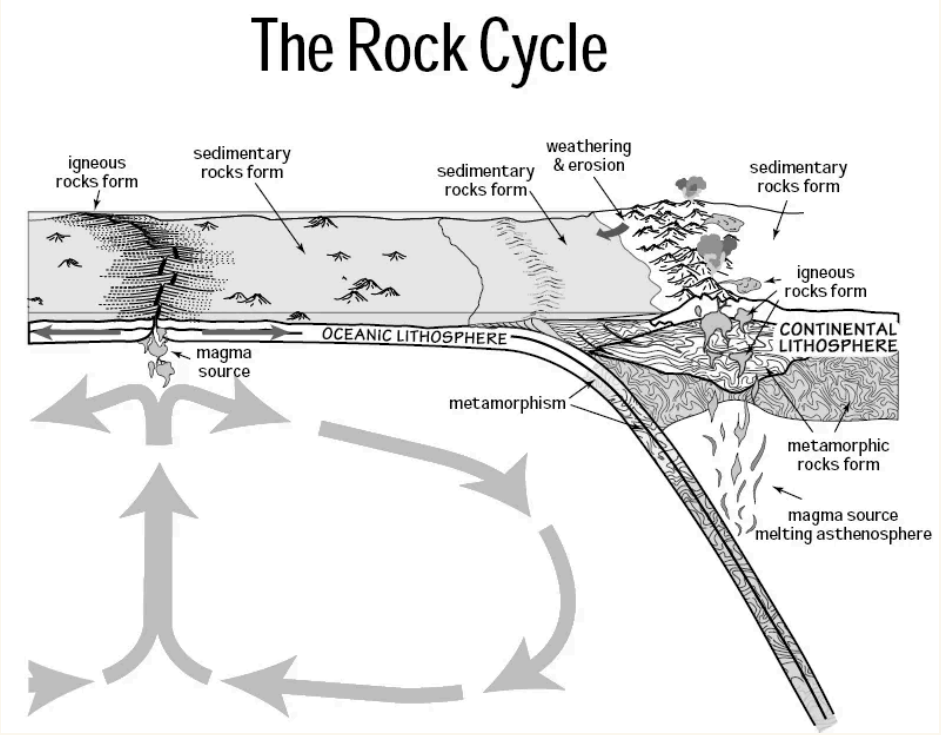
Types of Rocks: Igneous, Sedimentary, and Metamorphic

Every rock on Earth's surface belongs to one of just three families. Each family reveals a different chapter of how that rock came to exist.



The rock cycle: how igneous, sedimentary, and metamorphic rocks transform into each other. Diagram: US National Park Service, public domain, via Wikimedia Commons.

Three rock families, three distinct processes

Igneous from cooled magma, sedimentary from compacted layers, metamorphic from heat and pressure

01
Igneous

Forms when magma or lava cools and solidifies. Granite slowly, basalt quickly.

02
Sedimentary

Forms when sediment or organic matter compacts and cements into layers.

03
Metamorphic

Forms when heat and pressure transform existing rock without melting it.

04
The rock cycle

All three types connect: any rock can melt, erode, or be transformed into another.

Igneous rock Forms when magma or lava cools and solidifies, as in granite and basalt.
Sedimentary rock Forms from layered sediment or organic matter, usually compacted and cemented, or from minerals that settle out of water, as in sandstone, limestone and rock salt.
Metamorphic rock Forms when heat and pressure transform existing rock without melting it, as in marble and slate.

LithificationThe two-step process, compaction and cementation, that turns loose sediment into solid sedimentary rock.

What Are the Three Rock Families?

Must Know

How Each Family Forms

- Any natural mass of mineral matter that makes up the earth's crust is a rock. Rocks are made of minerals, naturally occurring substances with a definite chemical composition, and many, such as coal, petroleum, and natural gas, are used as fuels.
- Igneous rock forms when magma or lava cools and solidifies. Granite forms slowly underground, with large crystals. Basalt forms quickly at the surface, with fine grains, and builds the Deccan plateau.
- Sedimentary rock forms when sediment, mineral grains, or organic matter accumulate in layers and get compacted and cemented together. Some sedimentary rocks form instead when minerals settle out of evaporating water. These **evaporites** include rock salt and gypsum. Sandstone and limestone are common examples.
- Metamorphic rock forms when heat and pressure transform existing rock without melting it. Marble forms this way from limestone; slate forms from shale.

> **Quick check 1.** Q1. True or False: Igneous, Sedimentary, and Metamorphic are the three rock families; "Crystalline" is not a separate fourth family. *(True or False?)* See answer ↓

Quick check 2. Q2. True or False: Granite, which cools slowly deep underground and develops large visible crystals, is called intrusive igneous rock. *(True or False?)* See answer ↓

Intrusive vs Extrusive, Clastic vs Chemical

- Igneous rock that cools slowly underground is intrusive (or plutonic), with large, visible crystals, as in granite. Igneous rock that cools quickly at the surface is extrusive (or volcanic), with small, fine crystals, as in basalt.
- Clastic sedimentary rock forms from broken rock fragments, like sandstone from sand grains. Chemical or organic sedimentary rock forms from precipitated minerals or accumulated organic matter, like limestone from shell debris or coal from plant material.
- Sedimentary rock typically shows visible layering, called stratification, since each layer marks a separate depositional event. It is also the only rock type that commonly preserves fossils.
- **Foliated metamorphic rock, like schist and gneiss, develops banded texture under directed pressure. Non-foliated metamorphic rock, like marble and quartzite, recrystallizes without developing bands.**

Quick check 3. Q3. True or False: Basalt, which cools quickly at the surface, is a type of intrusive igneous rock. *(True or False?)* See answer ↓

Quick check 4. Q4. True or False: Marble, a non-foliated metamorphic rock, forms from limestone under heat and pressure. *(True or False?)* See answer ↓

Minerals, Metamorphism, and the Mohs Scale

Good to Know

Minerals: Properties, Hardness, and Classification

- A mineral is a naturally occurring substance with a fixed atomic structure and chemical makeup. Most combine two or more elements, though a few, like gold and sulphur, are pure single elements.
- Minerals are told apart by their cleavage (splitting along flat planes) or fracture (breaking irregularly instead). Lustre is their shine, and streak is the colour of their crushed powder.
- Ten reference minerals rank hardness on the Mohs scale, from softest to hardest: talc, gypsum, calcite, fluorite, apatite, feldspar, quartz, topaz, corundum, and diamond. A fingernail scores about 2.5, and glass or a knife blade scores about 5.5.
- Metallic minerals contain metal and split into three groups: precious metals like gold and silver, ferrous metals centred on iron, and non-ferrous metals like copper and zinc. Non-metallic minerals, like sulphur, gypsum and phosphates, are classed by how they are used, not by chemistry. They are not mined for a metal. Some, like gypsum, still contain metallic elements such as calcium.

> **Quick check 5.** Q5. True or False: Loose sediments are transformed into sedimentary rocks through lithification. *(True or False?)* See answer ↓

Quick check 6. Q6. True or False: Quartzite is metamorphosed sandstone, with heat and pressure fusing its quartz grains tightly together. *(True or False?)* See answer ↓

Metamorphism: Contact, Regional, and Dynamic

- Dynamic metamorphism comes from intense mechanical stress along faults and shear zones. Crushing and breaking is one main mechanism. Some rocks, like mylonites, are partly recrystallised under intense shear. Friction along faults can also make heat.
- **Contact metamorphism happens in the zone around hot intruding magma or lava, called the aureole. Heat, and sometimes fluids, reach the surrounding rock at varying distances from the contact. The heat recrystallises the rock, and fluids can add new minerals. This is the process, not dynamic metamorphism, when intruding magma's heat affects surrounding rock.**
- Regional metamorphism affects much larger areas. It comes from tectonic shearing combined with high temperature, high pressure, or both, typically deep within mountain-building zones. It often lines up minerals into layers, called foliation.

Quick check 7. Q7. True or False: Intense heat from intruding magma causes "dynamic" metamorphism in the surrounding rock. *(True or False?)* See answer ↓

Quick check 8. Q8. True or False: Most of the minerals that make up igneous rocks are silicates. *(True or False?)* See answer ↓

Think it through, before reading on. Heat from nearby magma causes metamorphism either way. So why does the exam distinguish “contact” metamorphism from “dynamic” metamorphism?

Show the explanation

The distinction is about mechanism, not just heat. Contact metamorphism happens in the aureole around hot intruding magma. Heat, and sometimes fluids, recrystallise the rock at varying distances from the contact. Dynamic metamorphism, by contrast, comes mainly from mechanical stress along faults and shear zones, not from the heat of intruding magma. Mixing the two up, crediting magma’s heat to “dynamic” metamorphism, is a common exam trap, since the two processes have different causes even when they occur in similar settings.

Remember the trap. Magma’s heat causes contact metamorphism, not dynamic metamorphism. Basalt is extrusive, not intrusive. Dolomite is sedimentary, not igneous.

Why This Matters: Economy and India's Named Rocks

Great to Know

The Rock Cycle, Ores, Fuels, and Building Stone

- The three rock types are not fixed categories. Weathering and erosion break any rock into sediment, which can become sedimentary rock. Heat and pressure can turn any rock into metamorphic rock. Enough heat melts any rock into magma, which cools into new igneous rock.
- Igneous activity concentrates many metallic ores as magma cools and crystallizes. India's copper and associated metal belts, and the Deccan Trap basalts themselves, both trace back to igneous processes.
- Sedimentary basins host most of the world's coal, oil, and natural gas, since these fuels form from buried organic matter under sedimentary layers. Sedimentary rock also hosts major groundwater aquifers.
- Metamorphic rocks supply valued building and dimension stone. Marble is prized for monuments and flooring; slate is used for roofing tiles; both owe their properties to the metamorphic process itself.

> **Quick check 9.** Q9. True or False: According to the rock cycle, melting and cooling converts any rock type into new igneous rock. *(True or False?)* See answer ↓

Quick check 10. Q10. True or False: Dolomite, like gabbro, granite, and basalt, is an igneous rock. *(True or False?)* See answer ↓

India's Rocks, Named

- The white marble of the Taj Mahal came from Makrana, Rajasthan, a metamorphic rock, formed from limestone recrystallising under heat and pressure.
- Every Ashokan pillar was carved from sandstone quarried at Chunar, in Uttar Pradesh's Mirzapur district, a sedimentary rock, cemented from ancient sand grains.
- The red sandstone across Agra Fort, Fatehpur Sikri, and Lahore Fort came from the same region, the standard building stone of the early Mughal period.
- Tuff, a light, porous rock, forms from compacted volcanic ash, including ash reworked and redeposited by rivers as a sedimentary layer.

Quick check 11. Q11. True or False: Tuff forms when volcanic ash is carried by running water and deposited as a sedimentary layer. *(True or False?)* See answer ↓

Quick Q&A

What are the three rock families?

Igneous, Sedimentary, and Metamorphic.

Which sedimentary rock does marble form from?

Limestone, under heat and pressure.

What process turns loose sediment into sedimentary rock?

Lithification, which is compaction and cementation.

What causes dynamic metamorphism, as opposed to contact metamorphism?

Mainly intense mechanical stress along faults and shear zones, not heat from intruding magma.

Previous Year Questions

PYQ

Six Exams, One Rock Cycle

> **Asked before**
> **PYQ 1 · UPSC CDS (I) 2021, Q54**
> Which one of the following is a type of igneous rock?
>
> (a) Marble
> (b) Halite
> (c) Granite
> (d) Shale
>
> mcqquestion.com/cds/cds-i-2021-general-knowledge-full-question-paper/#q54

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🔗 Related Topics

- **The Circum-Pacific Belt (Ring of Fire)** — the tectonic activity that directly produces this article's igneous rock, via magma and lava.
- **Paleomagnetism and Earth's Magnetic History** — another way scientists read the physical record locked inside igneous rock as it forms.
- **Geomorphology: Earth's Structure and Landforms** — the broader landform and tectonic framework this article's three rock families fit within.
- **Types of Mountains (Fold, Block, and Volcanic)** — the mountain-building processes that fold, uplift, and expose these three rock types at the surface.
- **The Andean Volcanic Belt: Ecuador's Volcanoes and the Ring of Fire** — a real-world case of igneous rock forming from active volcanic processes.
- **Ice Cores as Climate Records: Reading an Ancient Atmosphere** — another physical archive, alongside sedimentary rock layers, that preserves Earth's deep-time history.

✅ MCQ on Types of Rocks: Igneous, Sedimentary, and Metamorphic

🎲 More World Geography Practice

Practice MCQs

1. Rocks are classified into three families based on how they form.

Which of these is NOT one of the three?

- **A.** Crystalline
- **B.** Metamorphic
- **C.** Igneous
- **D.** Sedimentary

See answer ↓

2. Granite forms when magma cools slowly beneath the Earth's surface, producing large visible crystals. What is this type of igneous rock called?

- **A.** Intrusive
- **B.** Foliated
- **C.** Sedimentary
- **D.** Extrusive

See answer ↓

3. Marble is a non-foliated metamorphic rock.

Which sedimentary rock does it form from, under heat and pressure?

A. Coal

B. Limestone

C. Shale

D. Sandstone

See answer ↓

4. According to the rock cycle, which process converts any rock type into new igneous rock?

A. Directed pressure without melting

B. Weathering and erosion

C. Melting and cooling

D. Compaction and cementation

See answer ↓

5. Which one among the following statements regarding igneous rock is correct?

A. When magma cools deep in the Earth's interior, it results in the formation of fine-grained igneous rocks.

B. Basalt is a type of intrusive igneous rock.

C. Most of the minerals of igneous rocks are silicates.

D. Extrusive igneous rocks often undergo lithification.

See answer ↓

6. Consider the following statements regarding metamorphic rocks:

1. Ortho-metamorphic rocks are formed from igneous rocks.

2. Intense heat of the intruding magmas results in metamorphism of the surrounding rocks, a process known as dynamic metamorphism.

Which of the statements given above is/are correct?

A. 1 only

B. 2 only

C. Both 1 and 2

D. Neither 1 nor 2

See answer ↓

7. Loose sediments are transformed into sedimentary rocks by the process of

A. lithification

B. weathering

C. mass wasting

D. solifluction

See answer ↓

8. Quartzite is metamorphosed from which one of the following rocks?

A. Pegmatite

B. Limestone

C. Sandstone

D. Shale

See answer ↓

9. Which one of the following is not an igneous rock?

A. Gabbro

B. Basalt

C. Granite

D. Dolomite

See answer ↓

10. Which one of the following is formed when volcanic ash is carried by running water and is deposited as a sedimentary layer?

A. Slate

B. Basalt

C. Tuff

D. Lapilli

See answer ↓

Answer Key

1. **A.** The three rock families are igneous, sedimentary, and metamorphic, classified by their process of formation. 'Crystalline' describes a texture, not a formation-based family. ↑ Q1
2. **A.** Igneous rock that cools slowly underground is called intrusive, or plutonic, rock. Granite is the classic example, with large crystals from its slow cooling. ↑ Q2
3. **B.** Marble forms when limestone recrystallizes under heat and pressure. Slate, by contrast, forms from shale, and quartzite forms from sandstone. ↑ Q3
4. **C.** Enough heat melts any existing rock into magma, which then cools and solidifies into new igneous rock. Weathering/erosion feeds sedimentary rock, and heat/pressure without melting produces metamorphic rock instead. ↑ Q4
5. **C.** The correct answer is (c). Most igneous rock minerals genuinely are silicates. Magma cooling deep underground cools slowly, producing COARSE-grained rock, not fine-grained. Basalt is extrusive (forms at the surface), not intrusive. Lithification is a sedimentary process, not something igneous rocks undergo. ↑ Q5
6. **A.** The correct answer is (a) 1 only. Ortho-metamorphic rocks genuinely come from an igneous parent rock. Statement 2 misnames the process: heat from intruding magma causes CONTACT (thermal) metamorphism, not dynamic metamorphism. Dynamic metamorphism instead comes from shear stress along fault zones, not heat. ↑ Q6
7. **A.**
   Loose sediment, like sand, silt, or mud, needs to be squeezed and glued together to become solid rock -- this hardening process is called lithification.
   It involves two main steps: compaction (the weight of overlying layers presses grains closer, squeezing out water) and cementation (dissolved minerals fill the gaps and glue the grains together).
   Weathering is what breaks big rocks down into loose sediment in the first place.
   Mass wasting and solifluction both describe material moving downhill, not sediment turning into rock.
   So lithification is the correct process here, making option (a) the answer.
   ↑ Q7

8. **C.**
   Quartzite forms when sandstone gets buried deep and exposed to intense heat and pressure. Sandstone is made mostly of quartz grains, and this heat and pressure fuses those grains tightly together into quartzite, a much harder rock. Limestone, for comparison, metamorphoses into marble instead. Shale metamorphoses into slate, and later into schist or gneiss under even more pressure.
   So sandstone is the correct parent rock here, making option (c) the answer.
   ↑ Q8
9. **D.** Gabbro, granite, and basalt all form from cooling and solidifying magma or lava, making them igneous rocks. Dolomite is a sedimentary rock, a carbonate rock made mostly of calcium magnesium carbonate. This is why dolomite is the correct answer. ↑ Q9
10. **C.** Tuff is a light, porous rock formed from compacted and cemented volcanic ash, including ash reworked and redeposited by rivers and streams into sedimentary layers. Basalt forms from cooled lava, lapilli are loose pea-to-walnut-sized volcanic fragments, and slate is a metamorphic rock, none matching this water-deposited-ash description. This is why tuff is the correct answer. ↑ Q10

Quick-check answers

1. **True.** ↑ 1
2. **True.** ↑ 2
3. **False.** ↑ 3
4. **True.** ↑ 4
5. **True.** ↑ 5
6. **True.** ↑ 6
7. **False.** ↑ 7
8. **True.** ↑ 8
9. **True.** ↑ 9
10. **False.** ↑ 10
11. **True.** ↑ 11

Previous year answers

1. **(c) Granite** Granite forms from cooled magma, unlike metamorphic marble, or sedimentary halite and shale.

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