Here's a **comprehensive list of carbonate minerals**, organized by composition and categorized into common, rare, and metal-specific groups. Carbonates (CO_3^{2-}) are a major mineral class, forming in sedimentary, hydrothermal, and metamorphic environments.

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1. Common Carbonate Minerals

A. Calcium Carbonates

Mineral	Formula	Occurrence & Notes
Calcite	$CaCO_3$	Most stable polymorph; limestone, marble, shells
Aragonite	$CaCO_3$	Metastable (converts to calcite); marine sediments, pearls
Vaterite	$CaCO_3$	Rare, unstable polymorph; biogenic/ synthetic

B. Magnesium Carbonates

Mineral	Formula	Occurrence & Notes
Magnesite	$MgCO_3$	Serpentinite deposits; refractory material
Dolomite	$CaMg(CO_3)_2$	Dolostone rocks; forms via Mg replacement in limestone
Hydromagnesite	$Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O$	Cave deposits, weathering product

C. Iron Carbonates

Mineral	Formula	Occurrence & Notes
Siderite	$FeCO_3$	Bog iron ores, hydrothermal veins
Ankerite	$Ca(Fe,Mg)(CO_3)_2$	

Mineral	Formula	Occurrence & Notes
		Iron-rich dolomite variant

D. Sodium/Potassium Carbonates

Mineral	Formula	Occurrence & Notes
Nahcolite	$NaHCO_3$	Evaporite deposits; baking soda source
Trona	$Na_3(CO_3)(HCO_3)\cdot 2H_2O$	Alkaline lake beds (e.g., Green River Formation)

2. Rare & Complex Carbonates

A. Copper Carbonates (Brightly Colored)

Mineral	Formula	Color	Occurrence
Malachite	$Cu_2(CO_3)(OH)_2$	Green	Oxidized Cu zones
Azurite	$Cu_3(CO_3)_2(OH)_2$	Blue	Often with malachite

B. Lead/Zinc Carbonates

Mineral	Formula	Notes
Cerussite	$PbCO_3$	Lead ore; high density
Smithsonite	$ZnCO_3$	Zinc ore; pastel colors

C. Rare Earth Carbonates

Mineral	Formula	Notes
Bastnäsite	$(Ce,La)(CO_3)F$	Primary REE ore
Parisite	$Ca(Ce,La)_2(CO_3)_3F_2$	REE source

D. Uranium Carbonates

Mineral	Formula	Notes
Rutherfordine	UO_2CO_3	Secondary U mineral

3. Carbonate Classification by Structure

A. Anhydrous Carbonates

- Calcite group (trigonal): Calcite, magnesite, siderite, rhodochrosite ($MnCO_3$).
- Aragonite group (orthorhombic): Aragonite, cerussite, strontianite ($SrCO_3$).

B. Hydrous Carbonates

- Hydromagnesite, artinite ($Mg_2(CO_3)(OH)_2 \cdot 3H_2O$).

C. Carbonates with Additional Anions

- Hydrozincite ($Zn_5(CO_3)_2(OH)_6$, with OH^-.

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4. Key Geological Environments

1. **Sedimentary**:
   - Limestone (calcite), dolostone (dolomite).
   - Evaporites (trona, nahcolite).
2. **Hydrothermal**:
   - Veins (siderite, malachite).
3. **Metamorphic**:
   - Marble (recrystallized calcite/dolomite).
4. **Oxidized Zones**:
   - Secondary Cu/Pb/Zn carbonates (malachite, cerussite).

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5. Economic Uses

- **Construction**: Limestone for cement.
- **Metallurgy**: Flux in smelting (calcite, dolomite).
- **Pigments**: Malachite (green), azurite (blue).
- **Industrial**: Soda ash (from trona), REE extraction (bastnäsite).

Notable Facts

- **Calcite vs. Aragonite**: Same formula, different crystal structures (polymorphs).
- **Effervescence**: All carbonates react with HCl (diagnostic test).
- **Biogenic**: Shells (aragonite/calcite), coral reefs.

Need details on **specific localities** or **synthetic carbonates**? Let me know!

Here's a **detailed expansion** on carbonate minerals, including **notable localities**, **synthetic carbonates**, and **unique geological formations**:

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1. World-Class Carbonate Localities

A. Calcite & Aragonite Hotspots

Mineral	Locality	Special Features
Calcite	- Elmwood Mine, Tennessee (USA)	Giant fluorescent orange calcite crystals under UV light.
	- Iceland Spar (Helgustadir, Iceland)	Transparent "optical calcite" used in Viking sunstones (polarization navigation).
Aragonite	- Agrigento, Sicily (Italy)	"Aragonite roses" – flower-like clusters in sulfur mines.
	- Cave of the Crystals, Mexico	Meter-long gypsum + aragonite beams in Naica Mine (45°C, 100% humidity).

B. Malachite & Azurite Treasures

Mineral	Locality	Significance
Malachite	- Ural Mountains (Russia)	Historic source for tsarist art (e.g., Malachite Room in Winter Palace).
	- Katanga, DR Congo	Banded malachite ("peacock ore") with chrysocolla.
Azurite	- Tsumeb Mine (Namibia)	Deep-blue crystals up to 25 cm long.
	- Bisbee, Arizona (USA)	"Azurite suns" – radial crystal aggregates.

C. Rare Carbonate Localities

Mineral	Locality	Notes
Rhodochrosite		

Mineral	Locality	Notes
	Sweet Home Mine, Colorado (USA)	“Alma King” – famous 14-cm red rhodochrosite crystal (Denver Museum of Nature & Science).
Smithsonite	Kelly Mine, New Mexico (USA)	Pastel-blue “turquoise-like” zinc carbonate.
Cerussite	Tsumeb Mine (Namibia)	Glassy, twinned “arrowhead” crystals (collector’s favorite).

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2. Synthetic Carbonates & Industrial Production

A. Lab-Created Carbonates

Compound	Synthesis Method	Applications
Synthetic Calcite	Precipitation from $CaCl_2$ + Na_2CO_3	Paper coating, pharmaceuticals (antacids).
Sodium Carbonate (Soda Ash)	Solvay Process: NaCl + NH_3 + CO_2	Glass manufacturing (70% of global use).
Lithium Carbonate	Brine evaporation (e.g., Salar de Atacama)	Lithium-ion batteries, bipolar disorder medication.

B. Carbonate Nanomaterials

- **Nano-calcite**: Used in drug delivery (pH-sensitive coatings).
- **$MgCO_3$ nanoparticles**: Flame retardants in plastics.

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3. Unique Geological Formations

A. Natural Wonders

1. **Pamukkale Travertines (Turkey)**: White calcite terraces from hot springs (UNESCO site).
2. **Great Salt Lake (USA)**: Microbialites (living carbonate mounds built by cyanobacteria).
3. **Bahama Banks**: Modern carbonate platform (oolitic sand + aragonite mud).

B. Extreme Environments

- **Serpentinite-hosted carbonates**: Subsea hydrothermal vents (e.g., Lost City, Mid-Atlantic Ridge).
- **Mars Rover Findings**: Carbonate nodules ("blueberries") in Gale Crater hint at ancient water.

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4. How to Collect Carbonates

- **Field Guide Tips**:
  - Test with **dilute HCl** (fizz = carbonate).
  - UV light: Some calcites fluoresce **red/orange**.
- **Ethical Mining**: Avoid buying from conflict zones (e.g., artisanal Congolese malachite funds militias).

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5. Did You Know?

- **Vaterite**: Rare in nature but synthesized for **bone graft substitutes** (biocompatible).
- **Dolomite Problem**: No modern dolomite forms naturally—its origin remains a geological mystery!

Need **high-resolution images** of these localities or **synthesis protocols**? Let me know!

Here's a **comprehensive list of metal carbonates**, categorized by metal type (alkali, alkaline earth, transition, and post-transition metals), including natural minerals and synthetic compounds. Each entry includes the **chemical formula**, **occurrence** (if natural), and key **uses/properties**.

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1. Alkali Metal Carbonates

Compound	Formula	Occurrence/Uses
Lithium carbonate	Li_2CO_3	Lithium-ion batteries, bipolar disorder medication
Sodium carbonate (Soda ash)	Na_2CO_3	**Natural:** Trona ($Na_3(CO_3)(HCO_3)\cdot 2H_2O$). **Uses:** Glass, detergents
Potassium carbonate	K_2CO_3	Potash fertilizer, soap production
Rubidium carbonate	Rb_2CO_3	Laboratory reagent
Cesium carbonate	Cs_2CO_3	Organic synthesis, atomic clocks

2. Alkaline Earth Metal Carbonates

Compound	Formula	Occurrence/Uses
Beryllium carbonate	$BeCO_3$	**Rare;** toxic, lab-only
Magnesium carbonate	$MgCO_3$	**Mineral:** Magnesite. **Uses:** Refractory materials, supplements
Calcium carbonate	$CaCO_3$	**Minerals:** Calcite, aragonite, vaterite. **Uses:** Cement, antacids, chalk
Strontium carbonate	$SrCO_3$	**Mineral:** Strontianite. **Uses:** Fireworks (red flames), CRT glass
Barium carbonate	$BaCO_3$	**Mineral:** Witherite. **Uses:** Rat poison, ceramics
Radium carbonate	$RaCO_3$	Radioactive; no natural deposits

3. Transition Metal Carbonates

Compound	Formula	Occurrence/Uses
Manganese(II) carbonate	$MnCO_3$	**Mineral:** Rhodochrosite (pink). **Uses:** Mn source, ceramics
Iron(II) carbonate	$FeCO_3$	**Mineral:** Siderite. **Uses:** Iron ore (historically)
Cobalt(II) carbonate	$CoCO_3$	**Mineral:** Spherocobaltite. **Uses:** Pigments (blue glass)
Nickel(II) carbonate	$NiCO_3$	**Mineral:** Rare (gaspeite). **Uses:** Ni refining, catalysts
Copper(II) carbonate	$CuCO_3 \cdot Cu(OH)_2$	**Minerals:** Malachite (green), azurite (blue). **Uses:** Pigments, jewelry
Zinc carbonate	$ZnCO_3$	**Mineral:** Smithsonite. **Uses:** Zn ore, gemstones
Silver carbonate	Ag_2CO_3	**Synthetic:** Light-sensitive (turns black). **Uses:** Lab reagent
Cadmium carbonate	$CdCO_3$	**Toxic;** rare in nature. **Uses:** Cd plating (phased out)
Mercury(II) carbonate	$HgCO_3$	**Unstable;** decomposes to $HgO + CO_2$

4. Post-Transition & Other Metal Carbonates

Compound	Formula	Occurrence/Uses
Aluminum carbonate	$Al_2(CO_3)_3$	**Does not exist** in pure form (forms hydroxycarbonates like dawsonite)
Lead(II) carbonate	$PbCO_3$	**Mineral:** Cerussite. **Uses:** Lead ore (historically, now restricted)
Bismuth carbonate	$Bi_2(CO_3)_3$	**Synthetic;** used in pepto-bismol analogs
Uranyl carbonate	UO_2CO_3	**Mineral:** Rutherfordine. **Uses:** Nuclear fuel cycles
Lanthanide carbonates	$Ln_2(CO_3)_3$	**Minerals:** Bastnäsite, parisite (REE ores). **Uses:** Magnets, catalysts

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5. Mixed & Complex Carbonates

Compound	Formula	Notes
Dolomite	$CaMg(CO_3)_2$	**Rock-forming mineral;** steel flux, construction
Ankerite	$Ca(Fe,Mg)(CO_3)_2$	Fe-rich dolomite variant
Huntite	$Mg_3Ca(CO_3)_4$	Fire retardant, rare mineral
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$	Secondary Zn mineral; pastel colors

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Key Observations:

1. **Natural Abundance**:
   - Alkali/alkaline earth carbonates (e.g., calcite, dolomite) dominate Earth's crust.
   - Transition metal carbonates (e.g., malachite, siderite) are rarer and often form in oxidized ore zones.
2. **Stability**:
   - Most carbonates **decompose when heated** (e.g., $CaCO_3 \rightarrow CaO + CO_2$ at ~900°C).
   - Heavy metal carbonates (Pb, Cd) are **toxic** and environmentally restricted.
3. **Industrial Uses**:
   - **Construction**: Limestone ($CaCO_3$), dolomite.
   - **Batteries**: Li_2CO_3 (lithium), Na_2CO_3 (sodium-ion).
   - **Pigments**: Malachite (green), azurite (blue).

Did You Know?

- **Vaterite** ($CaCO_3$) is **metastable** and rare in nature but synthesized for biomedical implants.
- **Sodium carbonate** was historically extracted from **burned seaweed ash** ("soda").

Need **synthesis methods** or **crystal structure diagrams** for any of these? Let me know!

Here's a **comprehensive list of all known metal carbonates**, including natural minerals and synthetic compounds, organized by periodic group with key details:

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1. Alkali Metal Carbonates (Group 1)

Name	Formula	Natural?	Key Properties/Uses
Lithium carbonate	Li_2CO_3	Synthetic	Essential for lithium-ion batteries, mood stabilizer
Sodium carbonate	Na_2CO_3	Yes (trona)	Glass manufacturing (soda ash), water softener
Potassium carbonate	K_2CO_3	Yes (potash)	Fertilizer, soap production
Rubidium carbonate	Rb_2CO_3	Synthetic	Specialty glass, research
Cesium carbonate	Cs_2CO_3	Synthetic	Organic synthesis, atomic clocks
Francium carbonate	Fr_2CO_3	Theoretical	Radioactive (no practical use)

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2. Alkaline Earth Metal Carbonates (Group 2)

Name	Formula	Natural?	Key Properties/Uses
Beryllium carbonate	$BeCO_3$	No	Highly toxic, decomposes at RT
Magnesium carbonate	$MgCO_3$	Yes (magnesite)	Refractory bricks, antacids
Calcium carbonate	$CaCO_3$	Yes (calcite/ aragonite)	Cement, chalk, dietary supplements
Strontium carbonate	$SrCO_3$	Yes (strontianite)	CRT glass, red fireworks
Barium carbonate	$BaCO_3$	Yes (witherite)	Rat poison, ceramic glazes

Name	Formula	Natural?	Key Properties/Uses
Radium carbonate	$RaCO_3$	No	Radioactive (historical medical use)

3. Transition Metal Carbonates

Name	Formula	Natural?	Key Properties/Uses
Titanium(IV) carbonate	$Ti(CO_3)_2$	No	Unstable, lab curiosity
Vanadium carbonate	$V(CO_3)_2$	No	Theoretical only
Chromium carbonate	$CrCO_3$	No	Decomposes rapidly
Manganese(II) carbonate	$MnCO_3$	Yes (rhodochrosite)	Steel alloy additive, pink pigment
Iron(II) carbonate	$FeCO_3$	Yes (siderite)	Historical iron ore, jewelry
Cobalt(II) carbonate	$CoCO_3$	Yes (spherocobaltite)	Blue ceramics, catalysts
Nickel(II) carbonate	$NiCO_3$	Rare (gaspeite)	Nickel refining, batteries
Copper(II) carbonate	$CuCO_3 \cdot Cu(OH)_2$	Yes (malachite/azurite)	Pigments, gemstones
Zinc carbonate	$ZnCO_3$	Yes (smithsonite)	Zinc ore, turquoise-like gems
Silver carbonate	Ag_2CO_3	No	Light-sensitive (turns black), lab reagent
Cadmium carbonate	$CdCO_3$	Rare	Toxic (banned in most applications)
Mercury(II) carbonate	$HgCO_3$	No	Decomposes to HgO + CO_2

4. Post-Transition Metal Carbonates

Name	Formula	Natural?	Key Properties/Uses
Aluminum carbonate	$Al_2(CO_3)_3$	No	Forms hydrated hydroxycarbonates instead
Gallium carbonate	$Ga_2(CO_3)_3$	No	Lab curiosity
Indium carbonate	$In_2(CO_3)_3$	No	Electronics research
Tin(II) carbonate	$SnCO_3$	No	Unstable
Lead(II) carbonate	$PbCO_3$	Yes (cerussite)	Historical lead ore, now restricted
Bismuth carbonate	$Bi_2(CO_3)_3$	No	Pepto-Bismol analogs

5. Lanthanide & Actinide Carbonates

Name	Formula	Natural?	Key Properties/ Uses
Lanthanum carbonate	$La_2(CO_3)_3$	No	Phosphors, optical glass
Cerium carbonate	$Ce_2(CO_3)_3$	No	Catalysts, polishing compounds
Uranyl carbonate	UO_2CO_3	Yes (rutherfordine)	Nuclear fuel processing
Plutonium carbonate	$Pu(CO_3)_2$	No	Nuclear research (highly regulated)

6. Mixed & Complex Carbonates

Name	Formula	Type	Significance
Dolomite	$CaMg(CO_3)_2$	Mineral	Rock-forming, steel flux
Ankerite	$Ca(Fe,Mg)(CO_3)_2$	Mineral	Iron-rich dolomite variant
Huntite	$Mg_3Ca(CO_3)_4$	Mineral	Flame retardant
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$	Mineral	Secondary zinc deposit

Name	Formula	Type	Significance
Bastnäsite	$(Ce,La)(CO_3)F$	Mineral	Primary rare earth ore

Key Notes:

1. **Stability**: Most carbonates decompose when heated (e.g., $CaCO_3 \rightarrow CaO + CO_2$ at 900°C).
2. **Natural Abundance**: Alkali/alkaline earth carbonates dominate; transition metal carbonates are rarer.
3. **Toxicity**: Heavy metal carbonates (Pb, Cd, Hg) are restricted due to toxicity.

Synthetic Carbonates of Interest

- **Lithium nickel cobalt aluminum oxide (NCA)**: $LiNiCoAlO_2$ (battery cathodes)
- **Synthetic malachite**: Used for art restoration
- **Nano-calcite**: Drug delivery systems

Would you like **crystal structures** or **industrial synthesis methods** for any specific carbonate?