The Creation Of Limestone Cave

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Limestone cave

- Limestone cave the result of chemical weathering that occur because of the equilibrium reaction between $CaCO_3$ with CO_2 and H_2O
- Rain water is acidic

Limestone

- Main component of limestone is : $CaCO_3$
- $CaCO_3$:
  - Ionic compound that contain anion of a weak acid
  - Slightly soluble in water ($K_{sp} = 3.3 \times 10^{-9}$)
  - Soluble in acidic solution

2 key facts

1. In natural water, CO_2 gas in equilibrium with CO_2 (aq)

$$CO_2(g) \xrightleftharpoons{H_2O} CO_2(aq) \quad \text{.....eq. 1}$$

The concentration of CO_2 in water is proportional to the partial pressure of CO_2(g) in contact with the water (Henry`s Law)

$$[CO_2(g)] \approx P_{CO_2}$$

2 key facts

1. In natural water, CO_2 gas in equilibrium with CO_2 (aq)

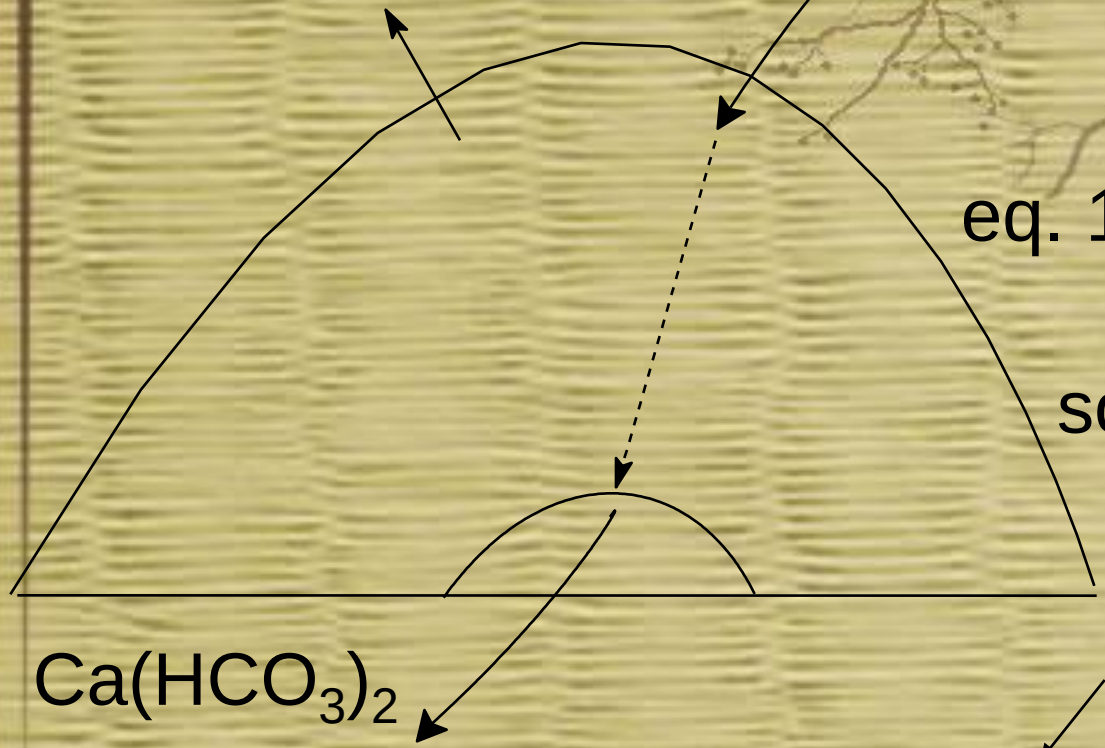
   – Because of continual release of CO_2 within the earth (out gassing), P_{CO_2} in soil trapped is higher than P_{CO_2} in the atmosphere

2. The present of $H_3O^+(aq)$ increases the solubility of ionic compound that contain the anion of a weak acid.
   - The reaction of CO_2 and H_2O produces H_3O^+

     $CO_2(aq) + 2H_2O(\ell)$

     $\leftrightarrow H_3O^+(aq) + 2HCO_3^-(aq)$

2. The present of $H_3O^+(aq)$ increases the solubility of ionic compound that contain the anion of a weak acid.
   - The present of $CO_2(aq)$ leads to the formation of H_3O^+, which increases the solubility of $CaCO_3$
   - $CaCO_3(s) + CO_2(g) + 2H_2O(\ell)$
     $\leftrightarrow Ca^{2+}(aq) + 2HCO_3^-(aq)$……eq.2



$P\ CO_2(sta) > P\ CO_2\ (atm)$

$Ca(HCO_3)_2$

$CO_2 + H_2O$

$[CO_2]>>>$

eq. 1 shift to right

solution more acidic

eq. 2 shift to right

$CaCO_3$ dissolved $\longrightarrow$ $Ca(HCO_3)_2$

limestone cave formed

$P\ CO_2(sta) > P\ CO_2\ (atm)$

↓

CO_2 (sta) meet air

↓

CO_2 come out of solution

↓

eq. 1 shift to left

↓

$CaCO_3$ precipitated on ceiling and the floor below

←

stalagtite and stalagmite formed