



CHINA UNIVERSITY
PETROLEUM, BEIJING

Wetting of water on surface of rock with CO₂ water reaction

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Outline

- Background
- Property of silica surface with water
- Property of silica surface with dehydration
- Effect of pH or H^+ on hydrophilicity of silica
- Effect of CO_2 on pH and the hydrophilicity of quartz surface
- Competitive adsorption between H^+ and water molecule
- Conclusion

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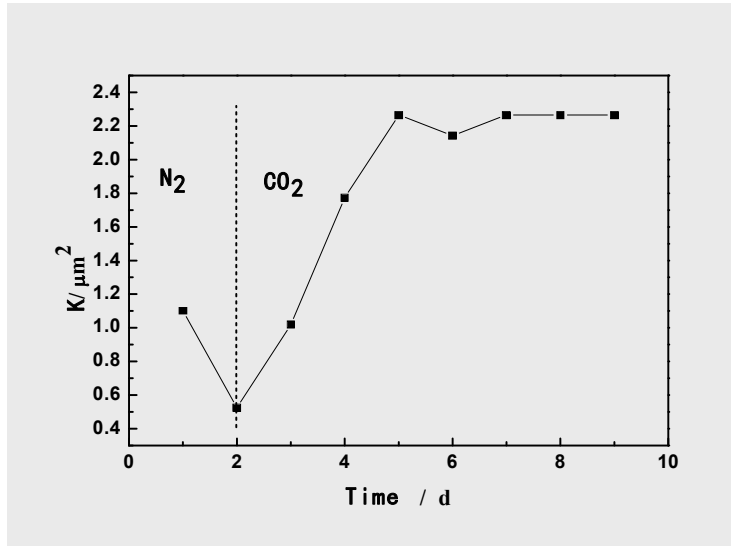
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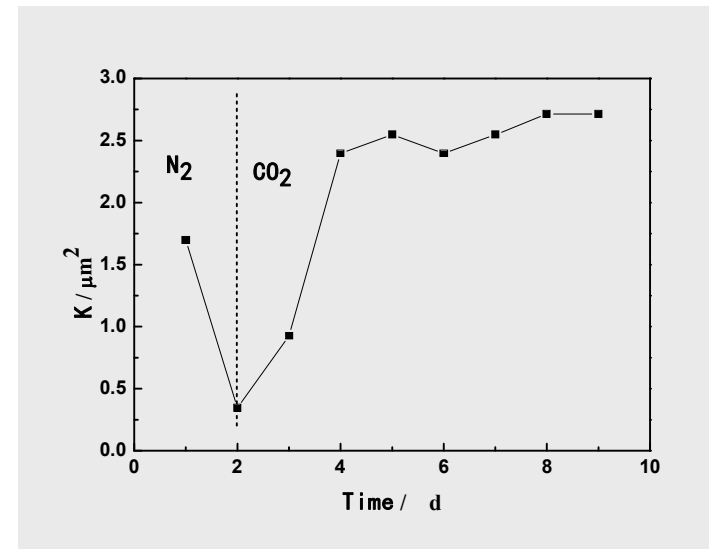




Background



2 MPa



5 MPa

Acid treated pure quartz sandpack with CO₂ or N₂ flooding, 30 ° C

The permeability of quartz sandpack with CO₂ flooding is increased
One of the reasons could be the change of the hydrophilicity of the sandpacks

How and why?



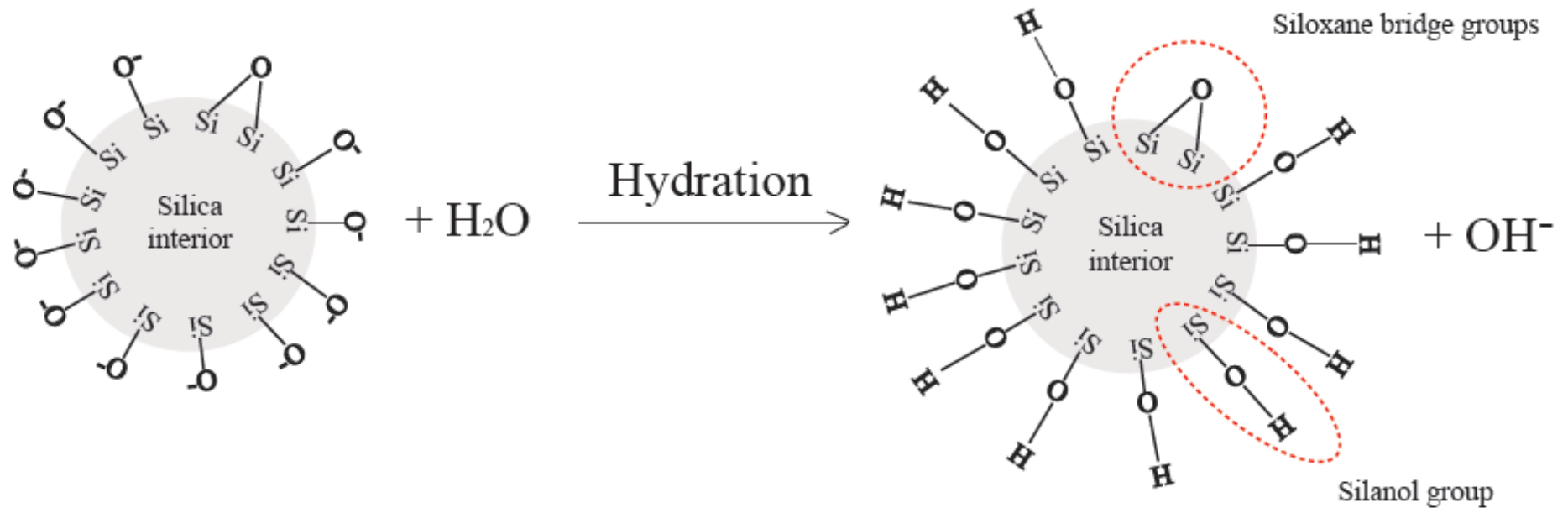
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Property of silica surface with water



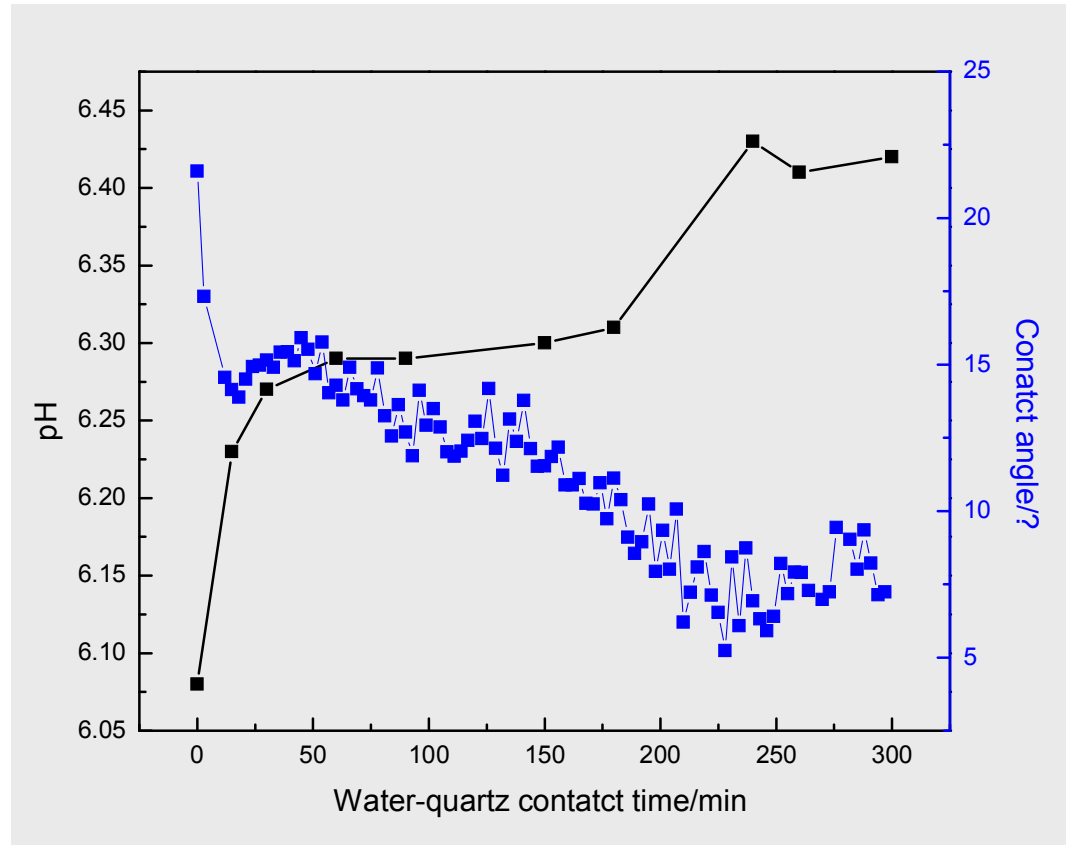
Two groups on the surface of silica after hydration

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Variation of water pH and contact angle with time , 20 ° C



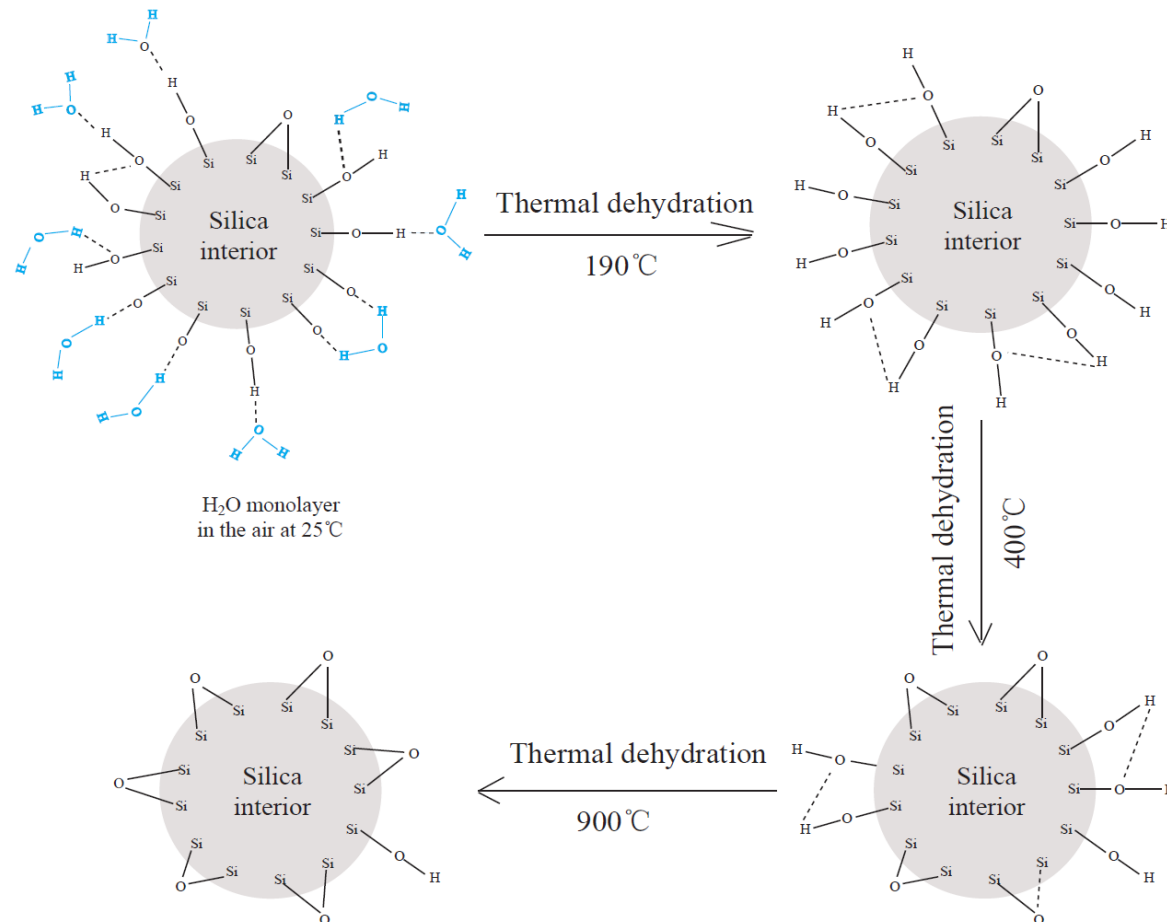
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Property of silica surface with dehydration

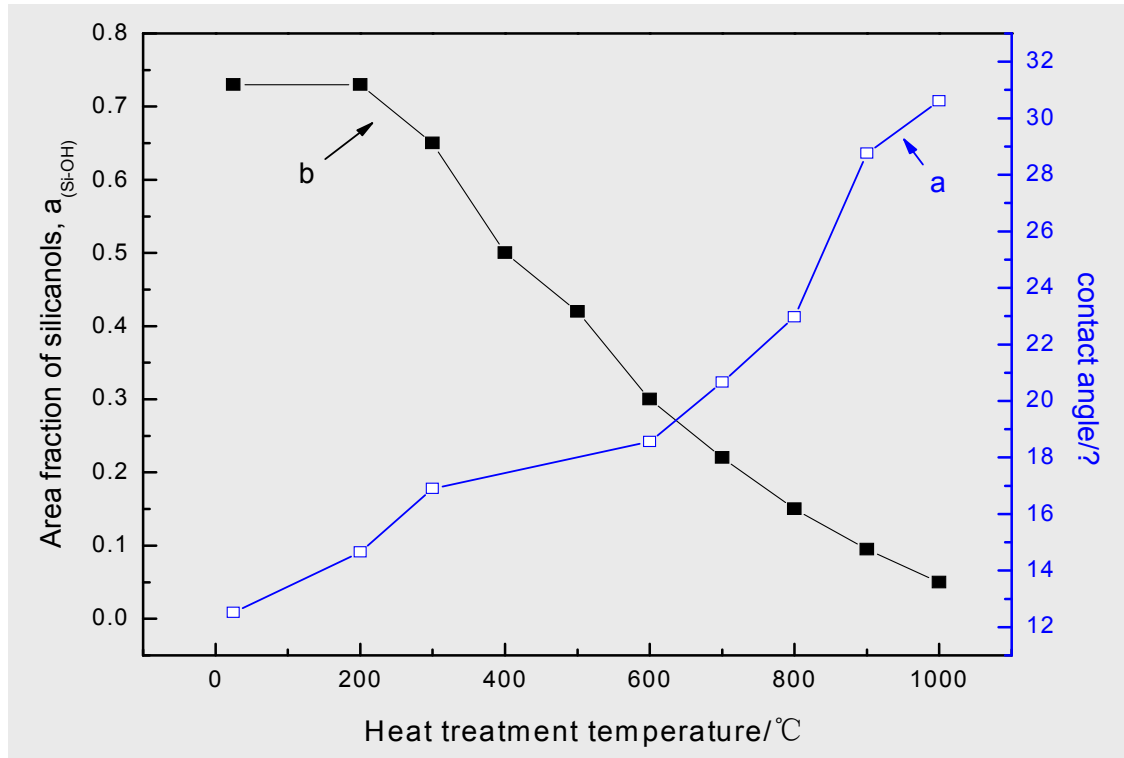


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Hydrophobic



Hydrophilic

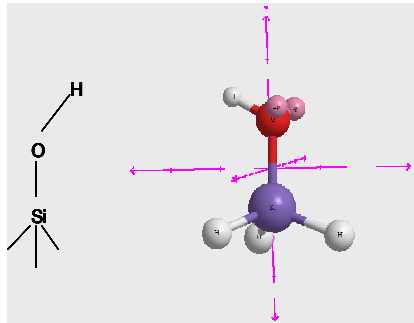
Variation of the fraction of **silanol group** and water contact angle on the surface of silica with temperature.



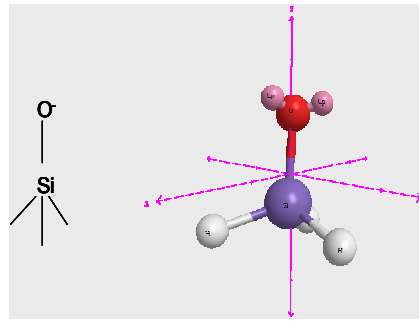
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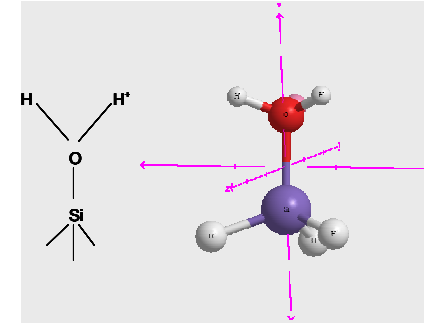




Neutral



Negative

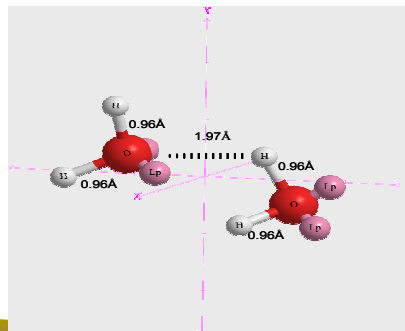


Positive

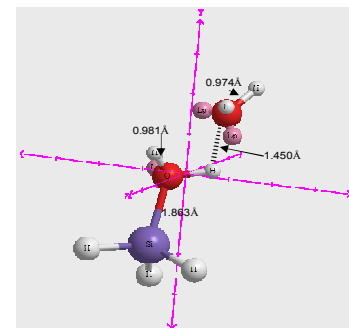
Silicanol groups	Hydrogen bond between water and silicanol groups (Å)
Neutrally charged ($\equiv \text{Si-OH}$)	1.845
Negatively charged ($\equiv \text{Si-O}^-$)	1.699
Positively charged ($\equiv \text{SiOH}_2^+$)	1.450

Hydrogen bond between water molecules is 1.97 Å.

Hydrogen bond between water



Hydrogen bond between water and positively charged silicanol group



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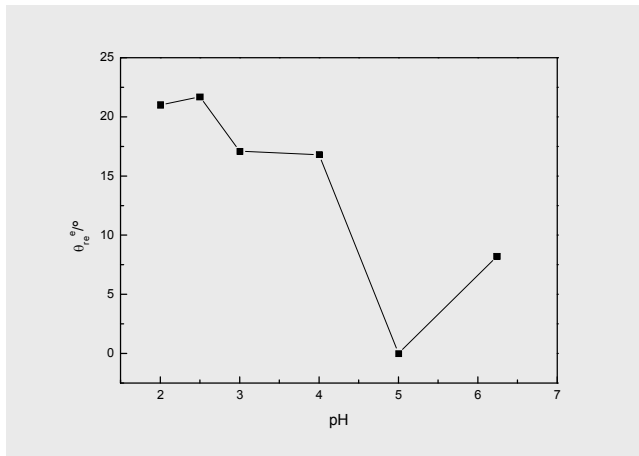
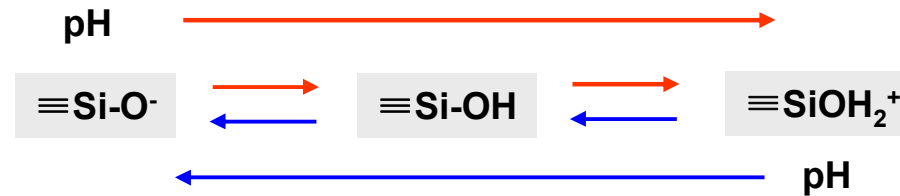
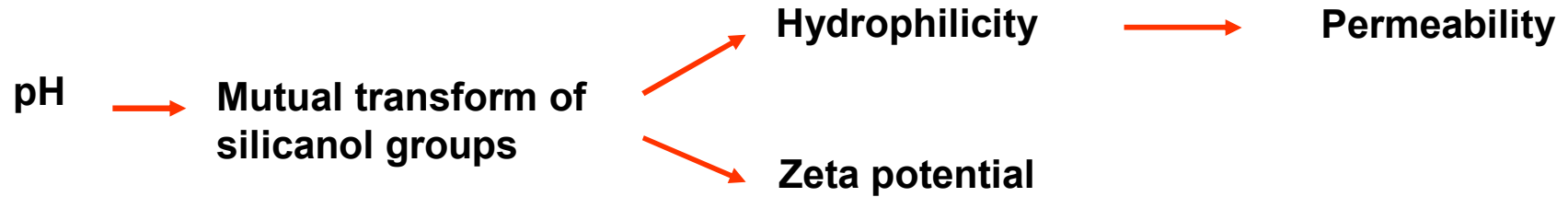
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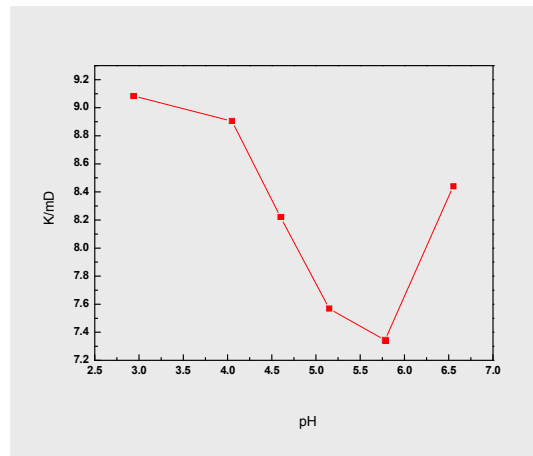




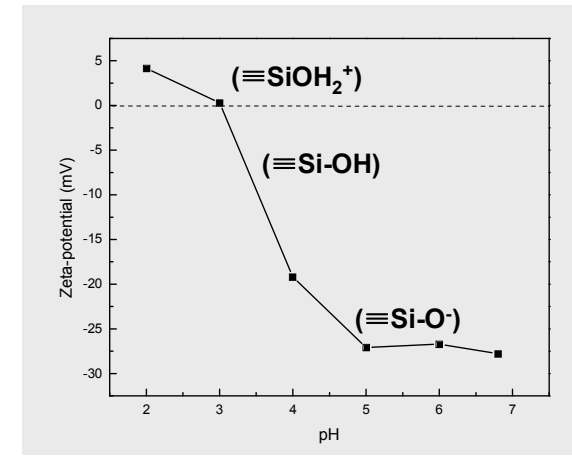
Effect of pH or H⁺ on hydrophilicity of silica



Contact angle



Permeability of natural rock



Zeta potential

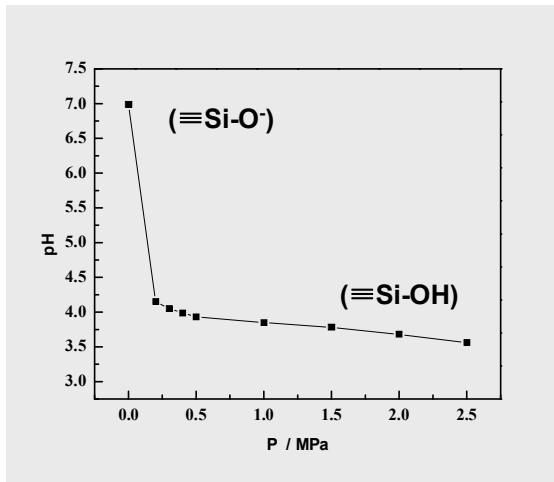


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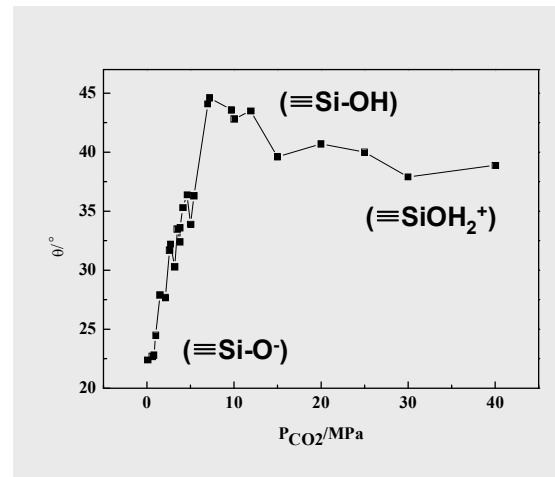




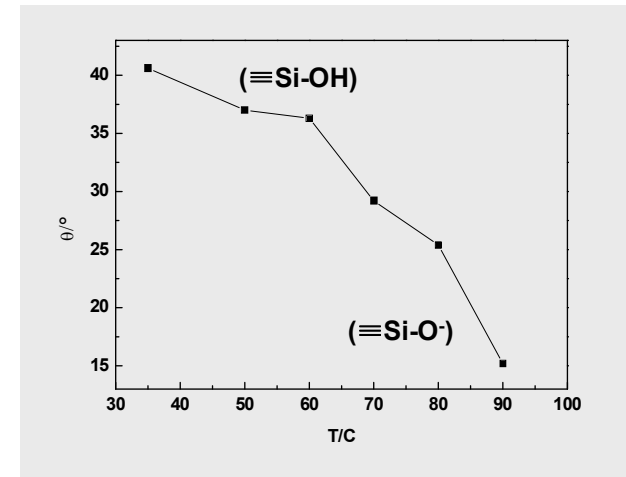
Effect of CO₂ on pH and the hydrophilicity of quartz surface



Temperature at 25°C



Temperature at 35°C



Pressure:20 MPa

pH and contact angle of water on quartz surface



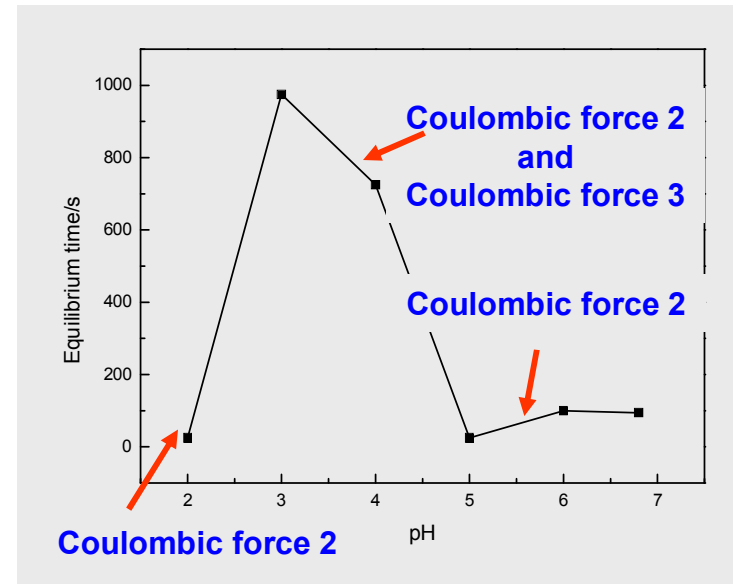
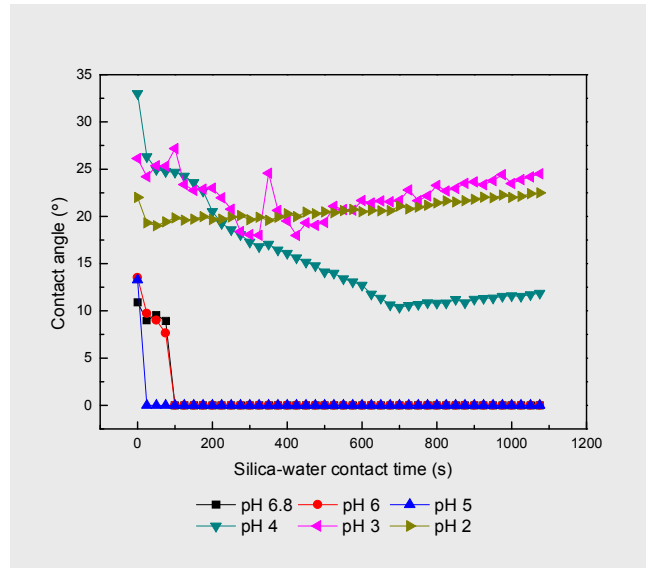
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Competitive adsorption between H^+ and water molecule



Equilibrium time of contact angle measurement with pH

Competitive adsorption between H^+ and water molecule on the surface of quartz caused by Coulombic forces



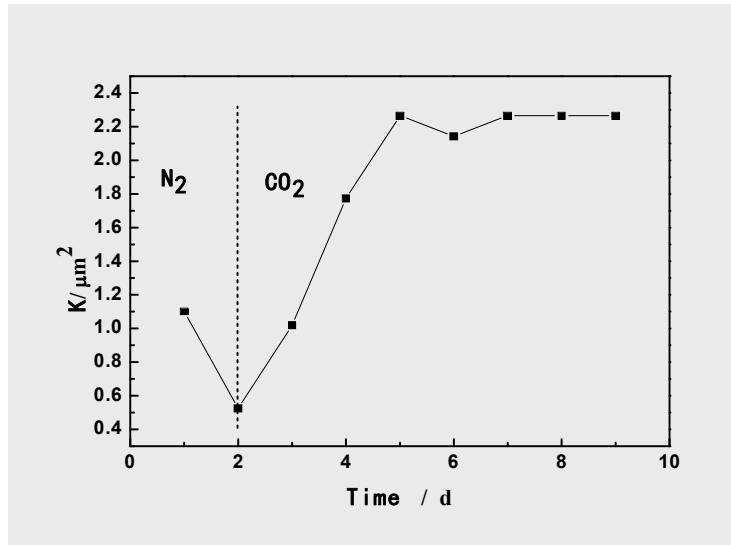
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Zeta potential 中澳二氧化碳地质封存

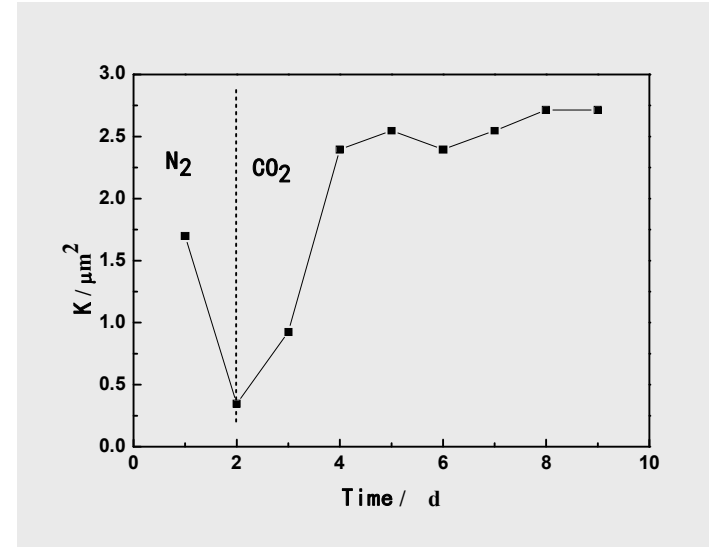




Conclusion



2 MPa



5 MPa

Due to the Coulombic force between the silanol groups on the quartz surface and water molecules is decreased, the hydrophilicity of quartz surface is decreased, therefore, the permeability of quartzite sandpack with CO₂ flooding is increased.



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