



The Puguang Gas Field in Sichuan Basin of China

-a case study for natural gas development issues

9 Oct 2008



Outline

1. An Overview of Puguang Gas Field

2. Project Plan

- Fracture prediction of carbonate reservoir
- Sour nature gas phase, elemental sulfur deposition prediction and its controlling & prevention techniques
- Edge/bottom water utilization and invasion controlling
- CO₂ capture and storage

1 An Overview of Puguang Gas Field

Puguang gas field, located at the northeast of Sichuan Basin, was discovered in 2003. It is the largest carbonate high sour gas field in China. Gas in initial place(GIIP) of Puguang has reached $300 \times 10^9 \text{m}^3$.

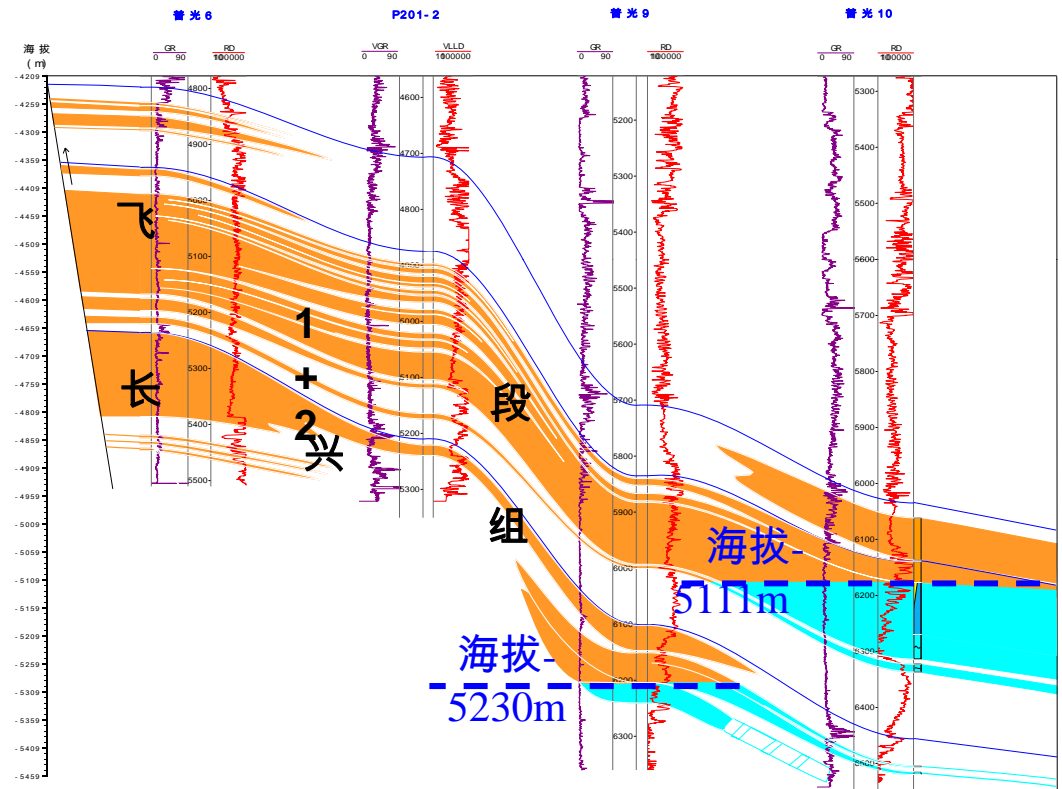


It, designed raw gas production 12 billion per year, will be put into production in 2009.



Reservoir Characteristics

- Elevation of water depth:
**Two different water-gas systems. Changxing formation :
-5230m
Feixianguan formation:
-5111m**
- Reservoir type:
**structural- lithologic
carbonate sour gas
reservoir**



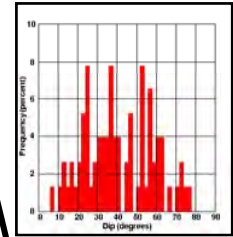
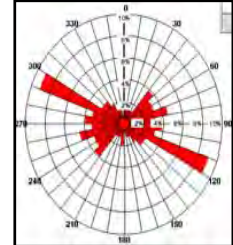
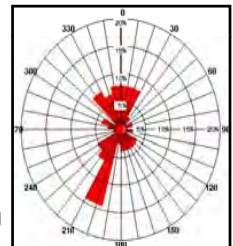
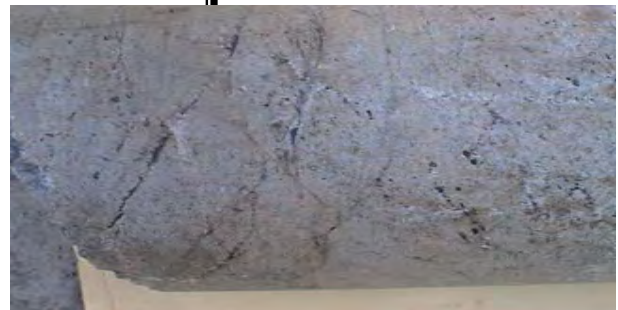
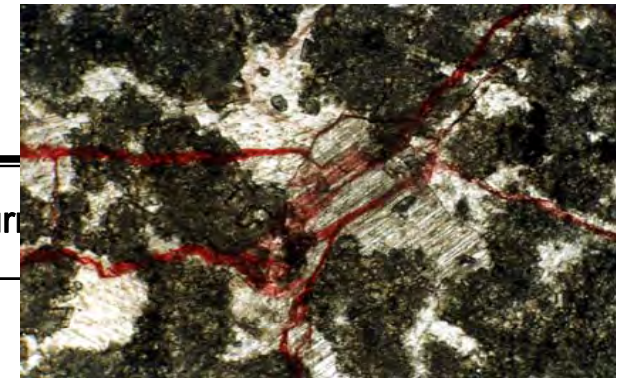
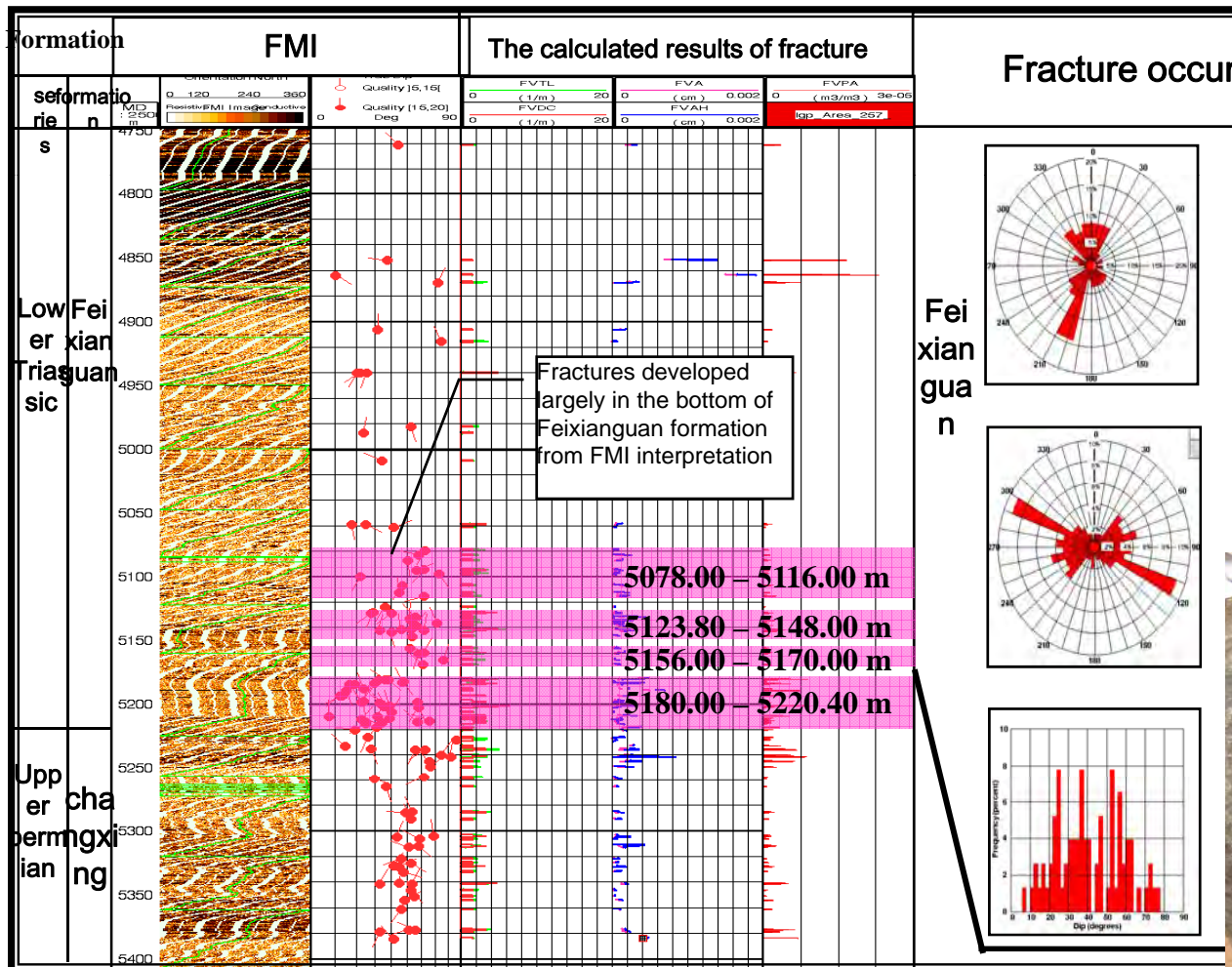
NO.P6-P10well reservoir profile



Project Plan

(1) Fracture prediction techniques of carbonate reservoir

Fractures developed largely in Puguang gas field, which can be recognized by core observation and FMI.



Problems

Fracture prediction is difficult in the world ,and which is the challenge in Puguang gas field.

- **Genetic mechanism of fracture : relationship among strata formation, lithology, lithofacies and fracture development is not clear.**
- **Seismic methods of fracture prediction : most of the methods are qualitative and ambiguous.**
- **Quantitative modeling fracture : quantitative description of effective fracture distribution is very difficult.**

Workshops

- **Fine description of fractured carbonate outcrop: the rules and mechanisms of fracture developing.**
- **Mechanical simulation of fracture: the mechanism of fracture developing, the relationship between fracture developing and structure&lithology.**
- **Identification method of fractures: how to identify natural effective fractures and induced ones based on FMI, and the accuracy of fracture identification based on conventional well log.**
- **3D seismic quantitative fracture prediction: seismic data quality, prediction methods.**
- **Modeling methods of fracture reservoir.**



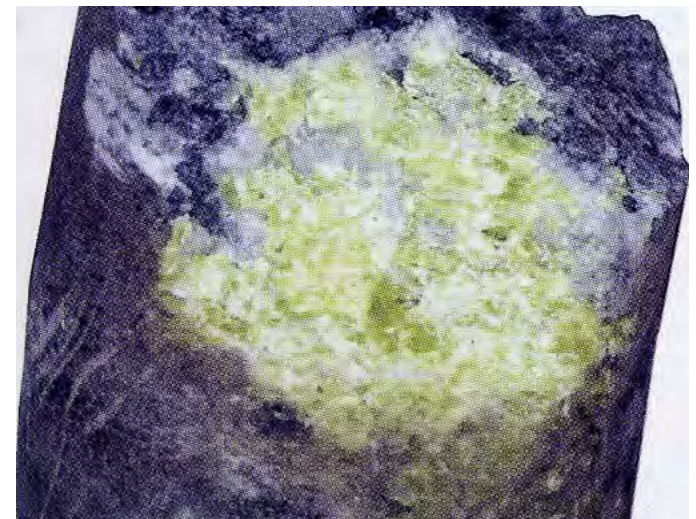
Plan & Schedule

- **Workshops and experts visiting : 2 ~ 3**
- **Expert team: Norway, Canada, United States or
CCOP MC experts 3 ~ 5**
- **Venue: China**
- **Time:2009 ~ 2010**

(2) Sour nature gas phase, elemental sulfur deposition prediction and its controlling & prevention techniques

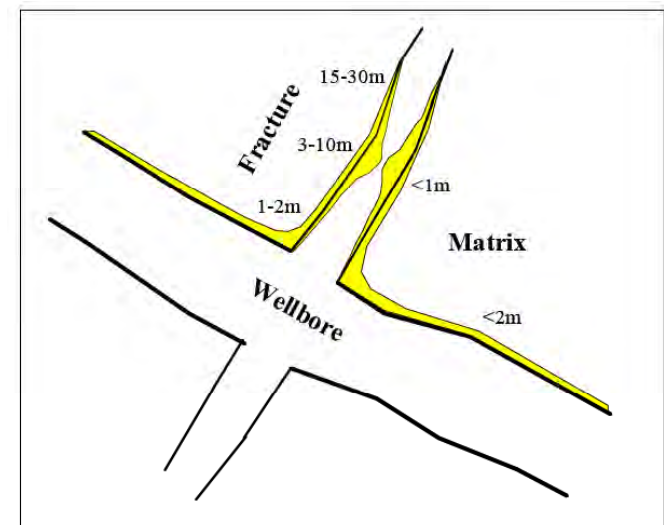
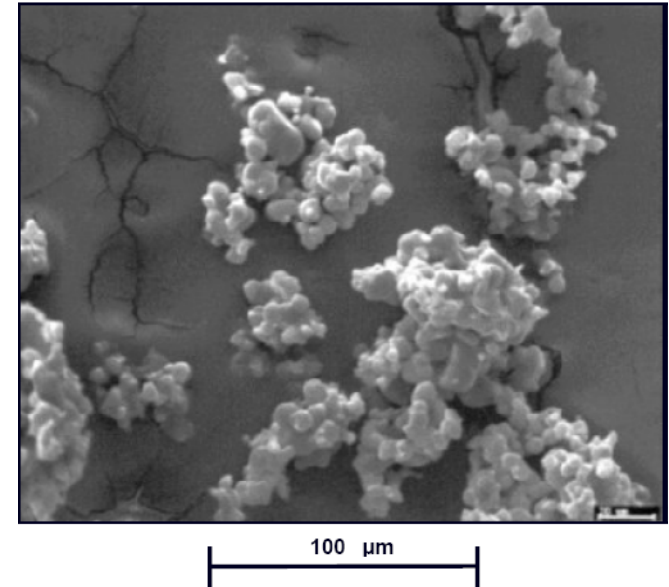
Problems

- It is very difficult to get sour gas phase experiment data. H_2S , a toxic and corrosive gas, usually makes experiment apparatus leak, even brings to human being or animals damage.
- It has great deviation on elemental sulfur deposition prediction in complex formation and multiphase percolation.



➤ General sulfur solvents are poor efficient ,
on the other hand, high efficient sulfur
solvents are not only expensive but also
unable recycled which always make pollution.

➤ Elemental sulfur deposited in formation far
away from the wellbore or fracture could not
be resolved by any sulfur solvent.





Workshops

- High sour gas phase experiment programs and phase characteristics,
- Elemental sulfur saturation experimental test and prediction model ,
- Physical simulation of elemental sulfur deposited in different media,
- Modeling elemental sulfur deposition in different flow media and multiphase,
- Developing economic, effective and clean sulfur solvent,
- Measurements to resolve elemental sulfur deposited in deep formation.

Plan & Schedule

- **Workshops or experts visiting: 2 ~ 3**
- **Expert team: Canada, United States , France
or CCOP MC experts 2 ~ 3**
- **Venue: China**
- **Time:2009 ~ 2010**

(3) Edge/bottom water efficient utilization and invasion controlling

It could enhance the natural gas recovery if edge/bottom water has been actively controlled and used its drive energy. Otherwise it would certainly cause water fast fingering, forming the seal gas range and creating the gas well flooding.

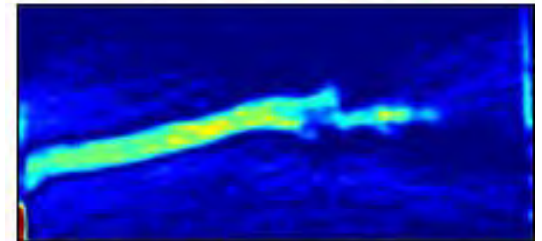
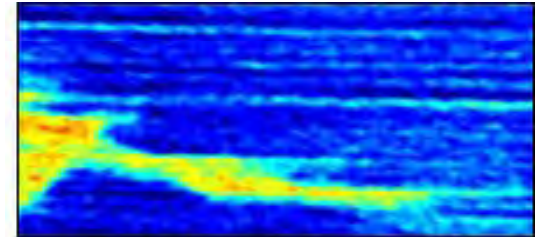
Possible problems that water invasion creates during sour gas field development:

- Pipelines and equipments corrosion rate increased,
- Gas well production and gas recovery decreased,
- It is difficult to treat produced water, which brings problems to the environmental protection.



Workshops

- Methods preventing water irregular coning/movement,
- Sealed gas second development techniques,
- Water gas well safe production and corrosion protection ,
- Wasted water reinjection and storage.





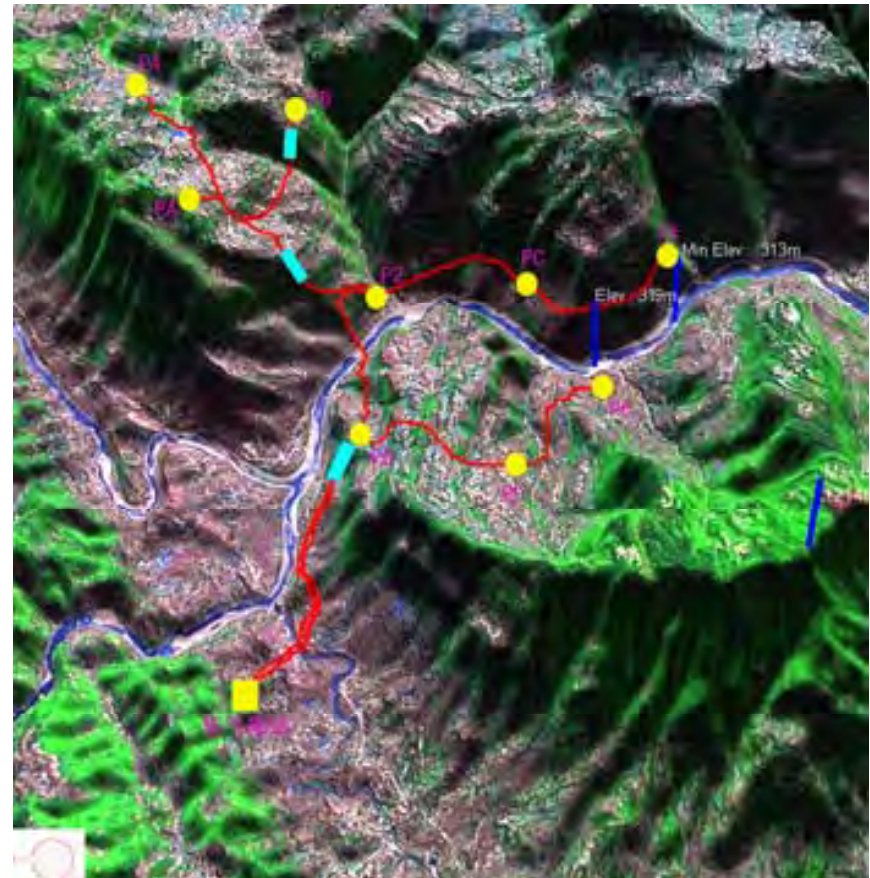
Plan & Schedule

- **Workshops and experts visiting: 2 ~ 3**
- **Expert team: Russian ,United States or CCOP MC
experts 2 ~ 3.**
- **Venue: China**
- **Time:2009 ~ 2010**

(4) CO₂ capture and storage

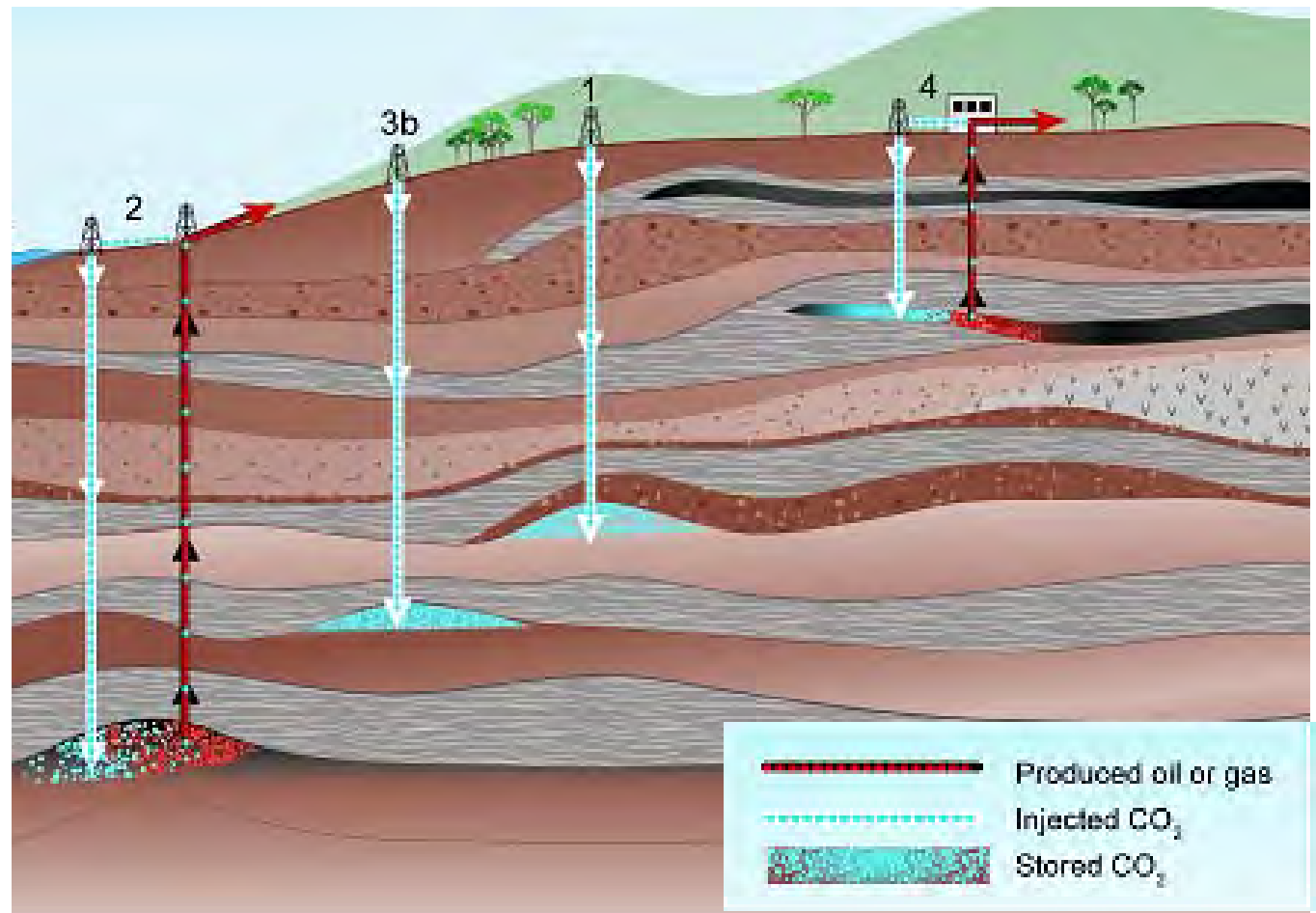
Technical aspect and questions

SINOPEC has attached importance to CO₂ purify and processing. The Puguang gas field located at mountain land and many gas pools scattered distributed are apart from the purification factory.



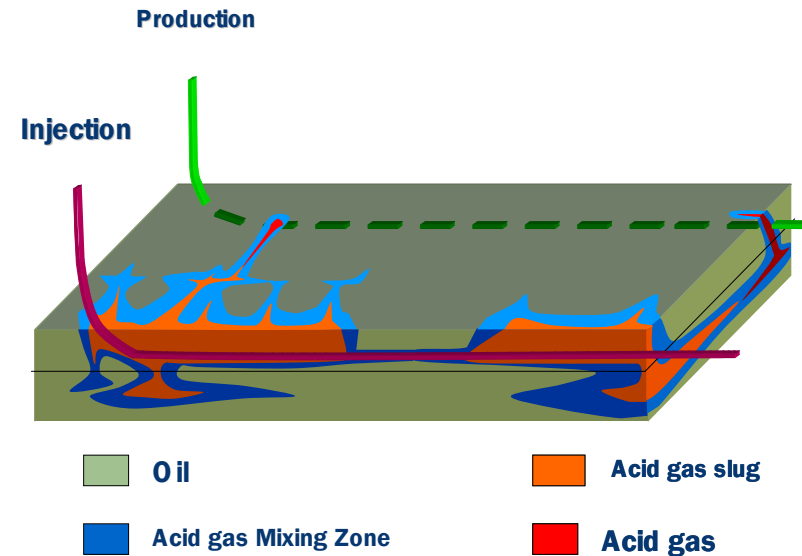


It ,therefore, has a long way to go for economic and effective sour gas field development. But the CO₂ capture and storage projects were few that made China petroleum companies lack the related experience.



Workshops

- ◆ Gas pool produced CO_2 economic clean capture and storage,
- ◆ Super critical properties of CO_2 and the effect to its reinjection,
- ◆ CO_2 corrosion protection and corrosion monitoring.





Plan & Schedule

- **Workshops and experts visiting: 2 ~ 3**
- **Expert team: Norway, Canada, United States or
CCOP MC experts 2 ~ 3.**
- **Venue: China**
- **Time: 2009 ~ 2011**

A photograph of a gas field drilling site. In the center, a tall, lattice-structured derrick stands prominently. A sign on the derrick reads "中国石油天然气集团公司" (China National Petroleum & Natural Gas Group) and "钻井三公司" (Drilling Company No. 3). The site is surrounded by various pieces of equipment, including storage tanks, pipes, and containers. In the foreground, there are some green plants and a red flag with white text. The background shows a hilly landscape under a clear blue sky.

Welcome to Puguang gas field!



Thank You!