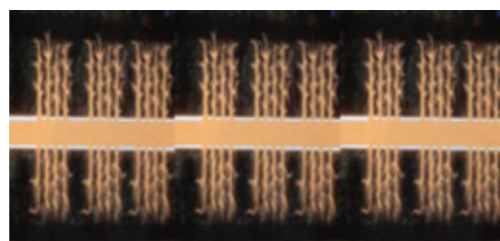
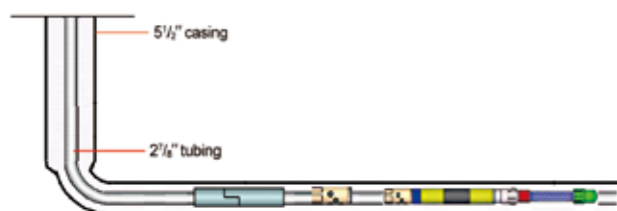




### New generation of hydraulic sand jet staged multi-cluster SRV fracturing techniques

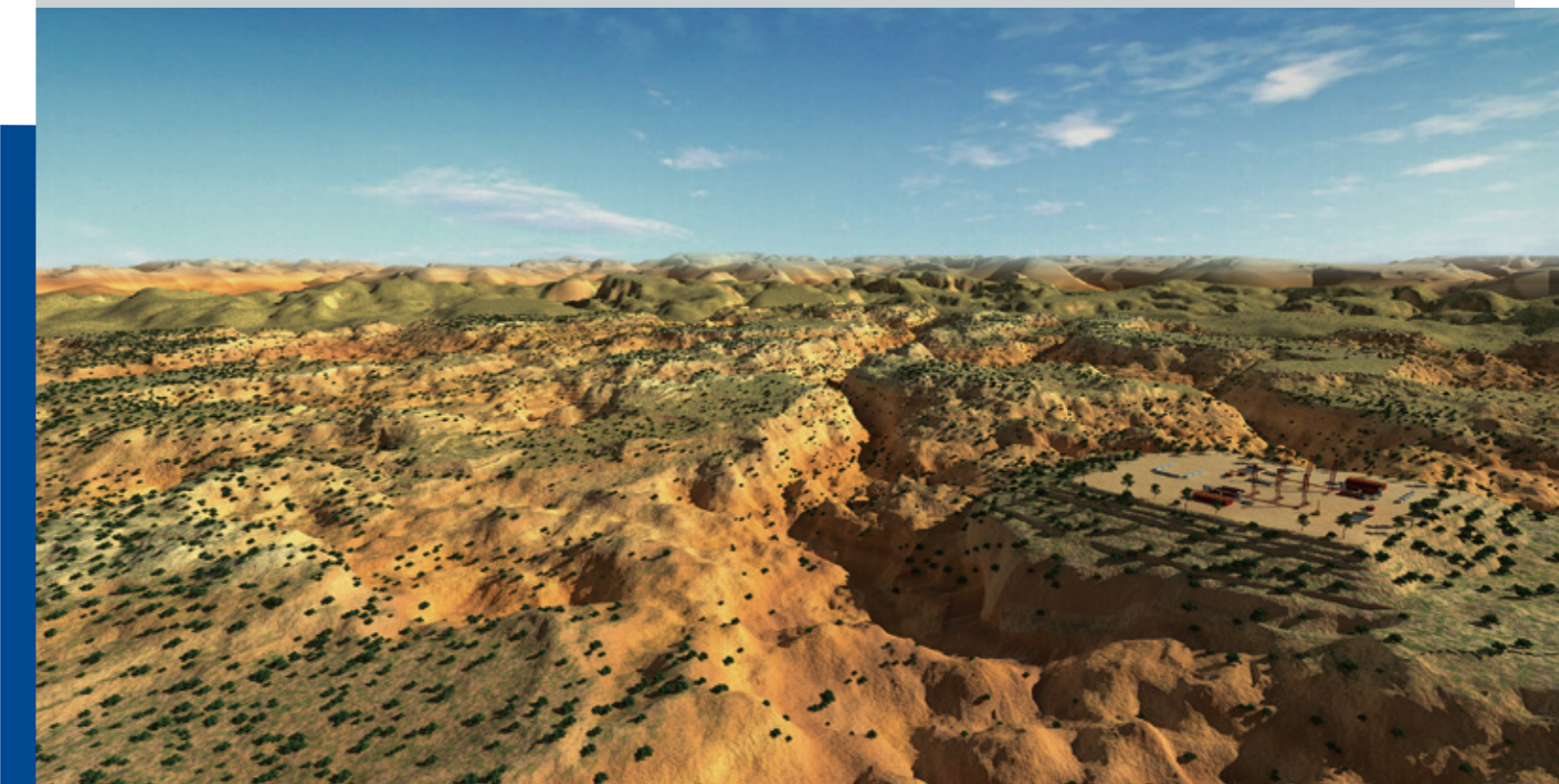
- ✓ Multi-jet sand blasting at one time: enabling multi-cluster perforation
- ✓ Annulus to be sand-carrying channel instead of tubing: enabling high flow rate fracturing at high pressure
- ✓ Improved isolation: applicable to large-scale long-term fracturing



### Application

We have launched tight oil development pilot in the Ordos basin at An 83-Chang 7 block in the northern Shaanxi, Zhuang 230-Chang 7 block and Zhuang 31-Chang 6 block in eastern Gansu, respectively. The three blocks are expected to have a total annual capacity of 1 million tons. So far, 499,000 tons of capacity has been available.

Horizontal well SRV fracturing at West 233 area has paid off. It was successfully applied in 10 horizontal wells, with each yielding over 100 cubic meters of oil flow during formation tests and maintaining an average daily output of more than 10 cubic meters during production tests. Favorable results were obtained at An 83 area, with the average daily output per individual horizontal well eight times higher than that in vertical wells.



## Tight Oil Development in the Ordos Basin

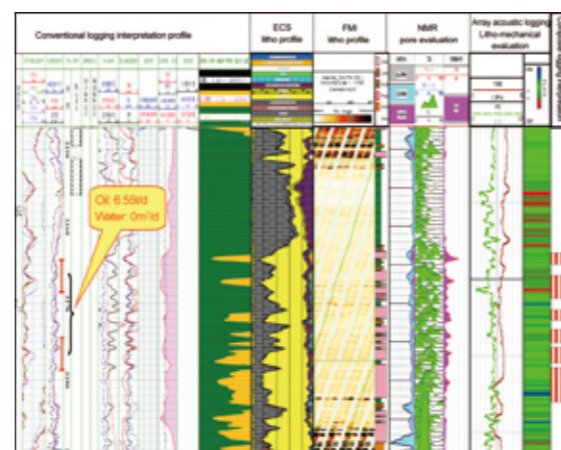
In recent years, CNPC has proven more than 100 million tons of tight oil reserves in the Ordos basin, and developed a package of technologies to tap these unconventional resources.

#### Four key technologies

- ✔ Tight oil reservoir evaluation and sweet spot prediction
- ✔ Tight oil development based on horizontal well SRV fracturing
- ✔ Extended-reach cluster horizontal well 3D drilling and completion for tight oil reservoirs
- ✔ Staged multi-cluster SRV fracturing for horizontal wells

#### Three supporting technologies

- ✔ Well logging for evaluation of reservoir quality, source rock quality and well completion quality
- ✔ Optimization of well pattern and development mode
- ✔ Optimal design of stimulated reservoir volume



Composite logging Interpretation

#### Tools for hydraulic sand jet SRV fracturing

- ✔ **Key components:** steel-strip long-rubber packer, and splash-proof jet
- ✔ **Main performance indexes:** resistant to 70 MPa, 5 1/2" and 4 1/2" casings

#### Tools for staged fracturing with fast-drilling bridge plug

- ✔ **Key components:** fast-drilling bridge plug, and multistage ignition device
- ✔ **Main performance indexes:** resistant to 70MPa and 175°C

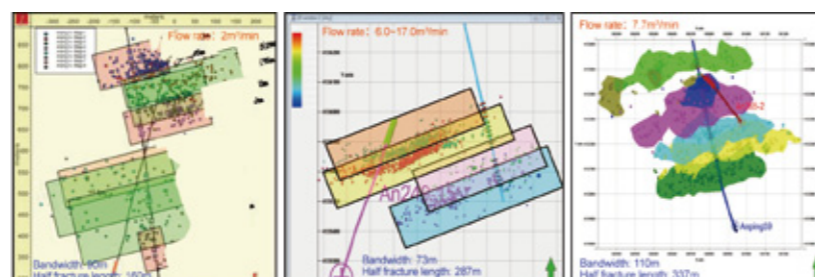
#### Tools for casing running in long horizontal intervals

- ✔ **Key components:** float coupling, roller centralizer, and rotating guide shoe
- ✔ **Main performance indexes:** string friction in horizontal intervals reduced by more than 30%

#### Three proprietary technologies for tight oil development by horizontal wells

- ✔ Optimization of tight oil horizontal well pattern
- ✔ Optimization of pressure system for tight oil development
- ✔ Economic evaluation of tight oil development

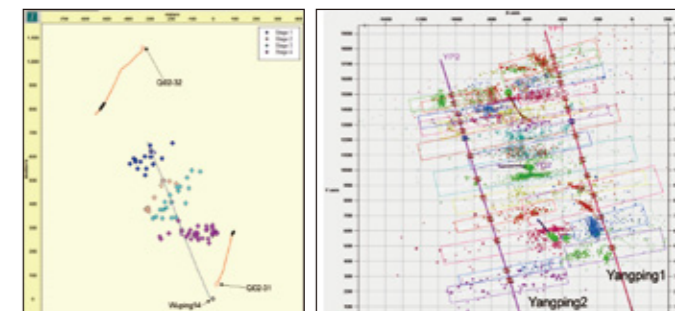
**Feature 1:** High flow rate SRV fracturing in horizontal wells can effectively expand the drainage volume, with single-fracture drainage volume 1.5 times of that in conventionally fractured wells, resulting in increased per-well output.



Micro-seismic fracture monitoring charts

**Feature 2:** Because large amount of fracturing fluid is injected during SRV fracturing, a large portion of the fluid remaining in the formation after flowback can create a relative high pressure zone around the horizontal borehole, with the pressure up to 116%-137%, supplementing the formation energy to a certain extent and playing a role as advanced water injection.

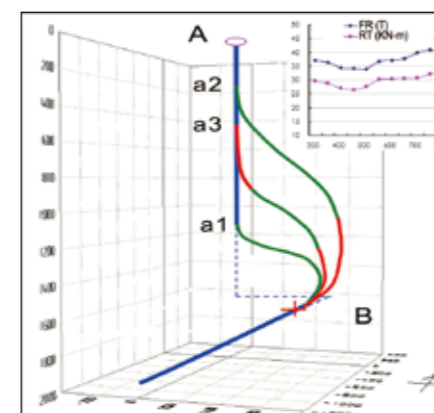
**Feature 3:** SRV fracturing can induce extensive and intensive fractures to form a complex fracture network system, resulting in higher risk of water breakthrough during waterflood and more difficulties in well pattern design.



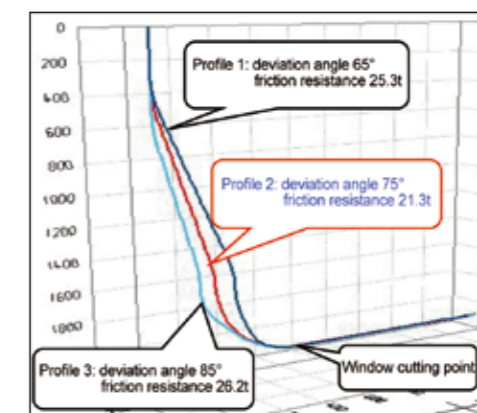
Conventional staged fracturing SRC fracturing  
Micro-seismic monitoring charts

#### Five proprietary technologies for cluster horizontal well drilling and completion in tight oil reservoirs

- ✔ Optimal 3D design of well profiles
- ✔ Hole trajectory control for extended-reach wells
- ✔ Collapse prevention for argillaceous siltstone reservoirs
- ✔ Floating casing running in long horizontal intervals
- ✔ Cementing by tenacious slurry



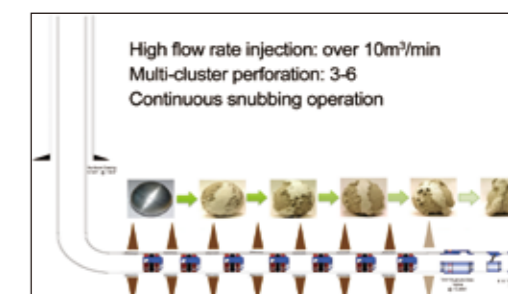
3D design of horizontal well profile



3D optimization of horizontal wellbore profile

#### Five key technologies for staged multi-cluster SRV fracturing of horizontal wells

- ✔ Optimal design of SRV fracturing in tight oil reservoirs
- ✔ Staged multi-cluster fracturing of horizontal wells
- ✔ Hydraulic sand jet and annulus sand loading fracturing
- ✔ Staged fracturing by hydraulic pumping with fast-drilling bridge plug
- ✔ Recyclable fracturing fluid with low viscosity and low friction



Composite bridge plug fracturing