The fast detection of core gas in gas hydrate drilling field in permafrost

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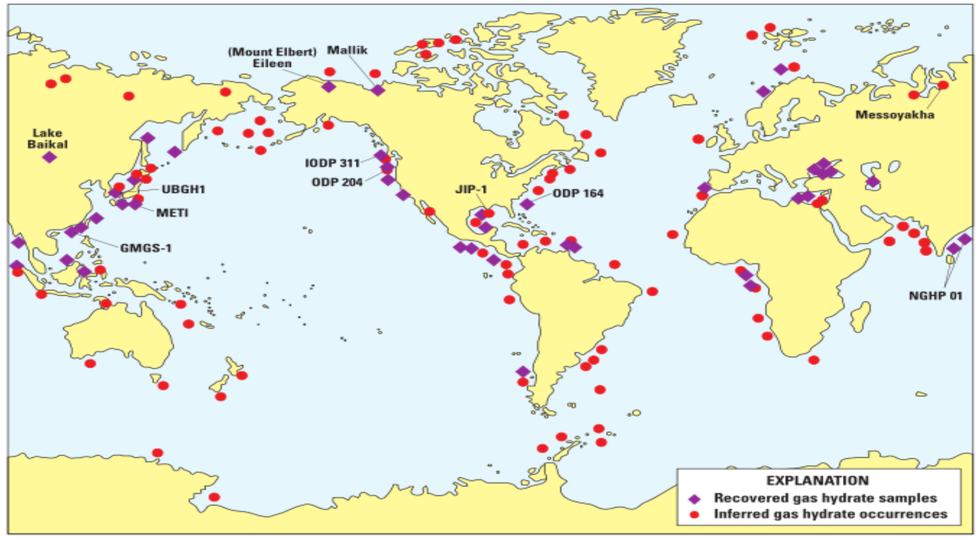
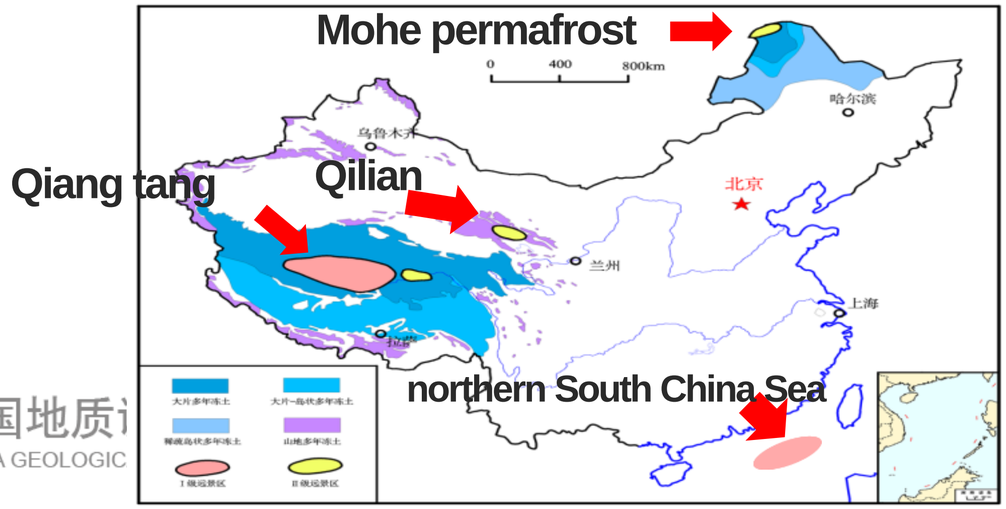
Outline

Research Background

WORLD GAS HYDRATE



CHINA GAS HYDRATE



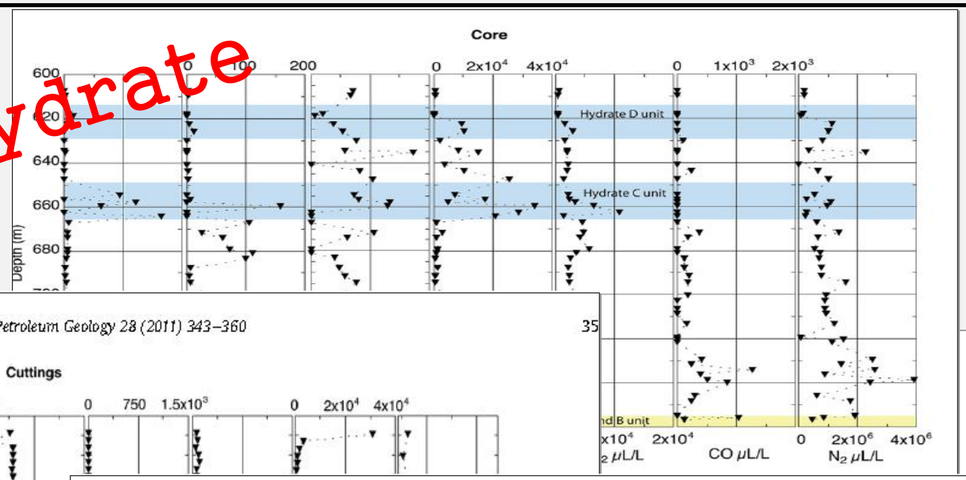
Gas hydrate

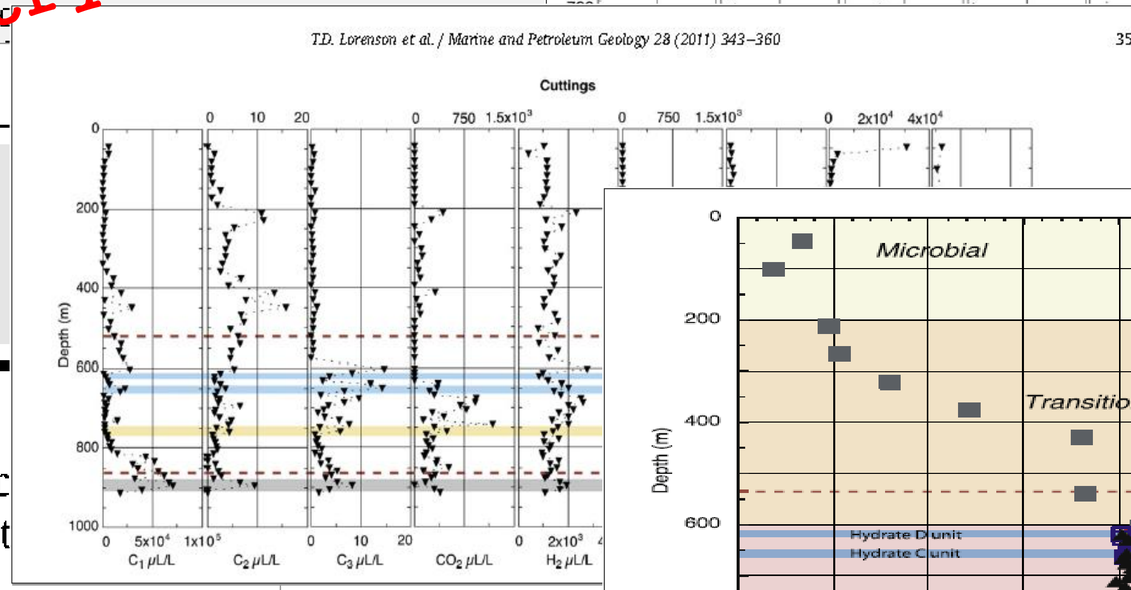
- Gas hydrate deposits are believed to be a larger hydrocarbon resource than all of the world's oil, natural gas and coal resources combined.
- The world's largest natural gas resource is trapped beneath permafrost and ocean sediments.
- In mainland China, potential gas hydrate sites are distributed mainly in the **Qiangtang**, **Qilian** Mountain, and the **Mohe** permafrost area.

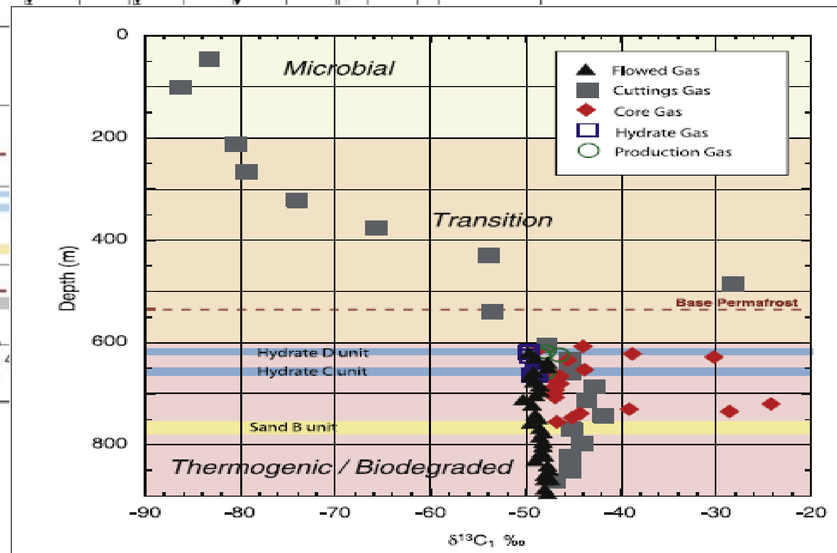
Research Background

Table 4
Gas hydrate gas composition.

Depth (ft)	Depth (m)	Core	Section	Interval (in)	O_2 + Ar (ppm)	N_2 (ppm)	N_2 (calc. ppm)	CO_2 (ppm)	H_2	CO (ppm)	C_1 (ppm)	C_2 (ppm)	C_2H_4 (ppm)	C_3 (ppm)	C_3H_6 (ppm)	iC_4 (ppm)	nC_4 (ppm)	iC_5 (ppm)
D Unit Sand																		
2029.50	618.75	2	7	15–16	85 800	302 700	3480	480	465	0								
2033.17	619.87	2	8	20–21	52 700	185 100	2960	490	413	0								
2033.56	619.97	2	8	31–36	22 800	309 700	228 000	4100	0	0								
2053.21	625.98	3	7	1–2	66 400	234 900	2050	470	466	0								
C Unit Sand																		
2148.50	655.03	7	6	30–31	97 000	345 600	550	470	435	0								
2155.04	657.02	7	8	36–37	120 000	462 600	34 400	370	501	0								
2162.46	659.29	8	4	1–2	134 400	487												







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GAS geochemistry for gas hydrate exploration !

Gas geochemistry of the Mount Elbert Gas Hydrate Stratigraphic … Alaska North Slope: Implications for gas hydrate exploration in t…

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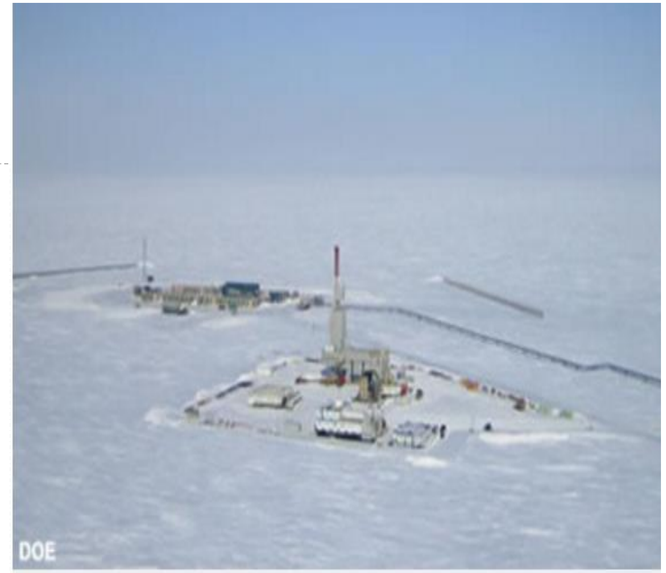
Existing Problems

- Drilling core observation is the most direct means of identifying gas hydrate.
- The identification of micro hydrate in the core by naked is no effective method.
- There is no fast core gas testing technique on site in gas hydrate drilling in permafrost in China.

Concentrated gas hydrate (white material) covered with mud. This core was obtained on the Blake Ridge during Ocean Drilling Program Leg 164.*Click image for larger view*.

Research Object

- Developing fast measuring methods of core gas on site for gas hydrate exploration in permafrost.
- Enhancing measuring capacity of drilling rock core gas.

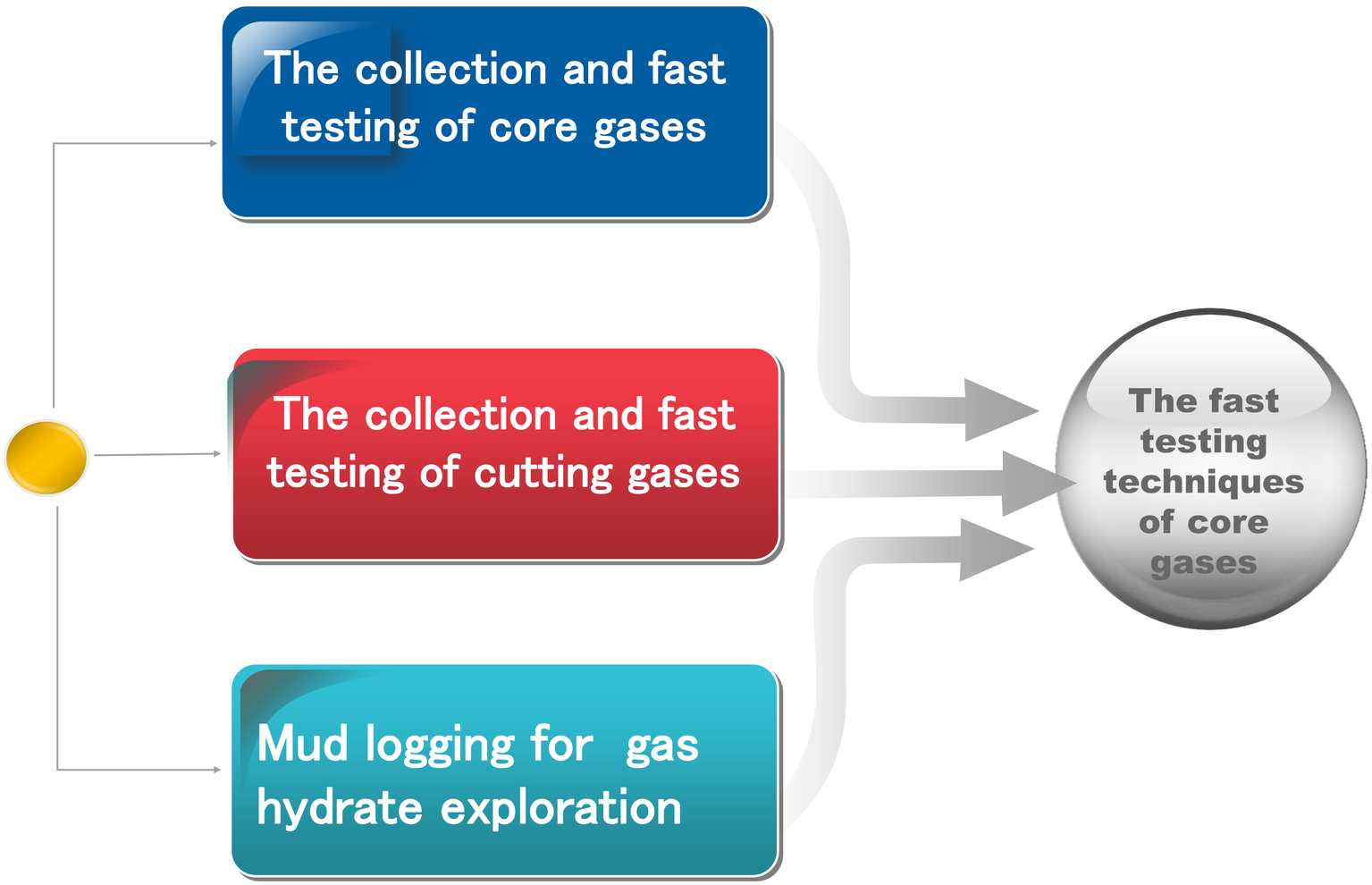


Gas hydrate well: Ignik Sikumi #1 gas hydrate well on the Alaska North Slope. A USGS gas hydrate resource assessment determined that the North Slope has an extensive gas hydrate resource trapped below permafrost. Department of Energy photo.

Major Achievements

The fast testing techniques of core gases

- A range of the fast testing methods of core gas in gas hydrate drilling field in permafrost were established.
- These methods include detection of core gases ,cutting gases and mug logging.
- The testing targets are comprised of the hydrocarbons gases (C_1-C_8) and non-hydrocarbon gases(CO, He, CO_2, N_2,H_2, O_2 Ar and H_2S)



Major Achievements

1.Sampling collection for gas hydrate core gas

The collective components of core gas	The collective method of core gas	Pain points
The accurate quantitative collection of the hydrocarbons (C_1-C_8) and non-hydrocarbon gases(CO, He, Ar, N_2,H_2 and O_2) in rock core.	A. Vacuum degassing method- It is difficult to operate, prone to negative pressure or air leakage. B. Headspace method -Air interference cannot be avoided	The core gas is easily disturbed by air during the core gas desorption and collecting processes.

Major Achievements

- ✓ Frist generation vacuum degassing can. Degassing of rock core gas by vacuum.
- ✓ Second Generation Underwater Degassing Can. The use of natural pressure and gas drainage principle
- ✓ The third generation microwave degassing can. Degassing of rock core gas by microwave underwater.

Frist Generation Vacuum Degassing Can

Second Generation Underwater Degassing Can

The third Generation Microwave Degassing Can

The third Generation Microwave Degassing Can

Major Achievements

1.Sampling collection for gas hydrate core gas

Second d Generation

Underwater Degassing Technique

The desorption and collection of rock core gas

Method feature

Accuracy, no air interference, simplicity, economy

Gas sample collected

Major Achievements

2. Method of determination for natural gas hydrate core gas .

The 4 gas analytical methods have been developed for the exploration and research of gas hydrate.

01 Determination of C_1—C_8 in core gas by GC

02 Determination of O_2,N_2, Ar and CO by GC

03 Determination of CO_2, H_2S in core gas by GC

04 Determination of He,H_2 in core gas by GC

Major Achievements

The comparison of Method Limit of Detection between gas chromatography(GC) and cold trap gas chromatography(CT-GC)

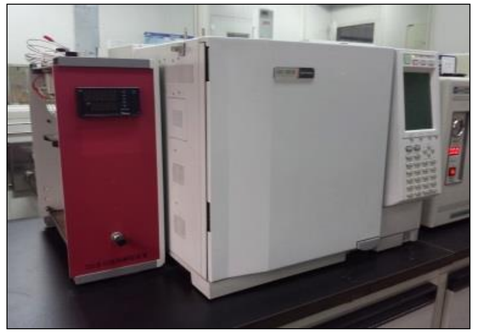
Unit:μ L/L

Method	CH_4	C_2H_6	C_2H_4	C_3H_8	C_3H_6	C_4H_{10}	n-C_4H_{10}	C_5H_{12}	n-C_5H_{12}
CT-GC	0.05	0.03	0.05	0.05	0.05	0.01	0.01	0.01	0.01
GC	1.50	0.50	0.50	0.10	0.10	0.10	0.10	0.10	0.10

Method feature

Method Limits of Detection were lower 1 ~ 2 orders of magnitude。

The cold trap part made

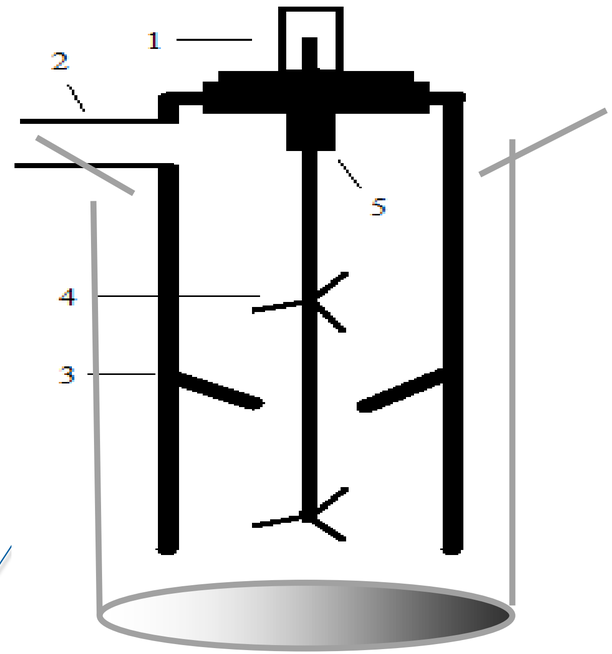


The system of CT– GC

Major Achievements

3. Study on measurement of cutting gas

Home-made rock cutting collection device + Sampling method developed by ourselves for core gas + Rock core gas analytical method = The cutting gas measuring method



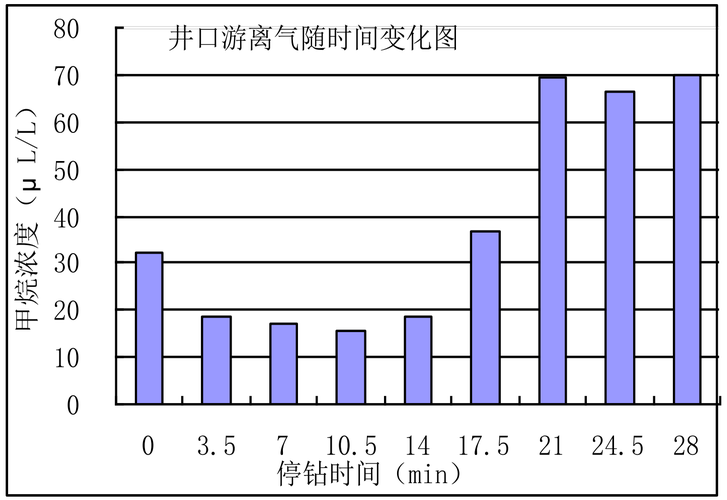
Home-made rock cutting collection device

Major Achievements

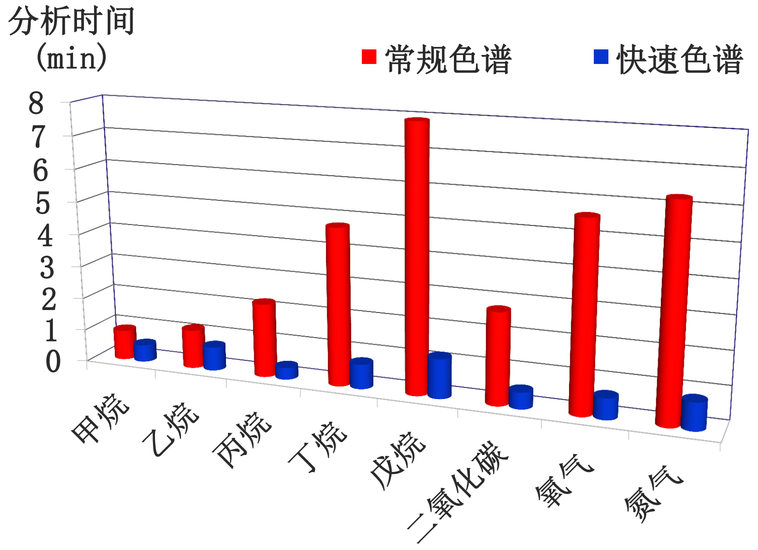
4. Study on testing of free gas in drilling well

The fast determination of C_1-C_5、O_2、N_2、CO_2、CO、H_2S、H_2 of free gas in drilling well using pocket rapid GC with four detector (inficon 3000).

The free gas in drilling well was testing.



The concentration of free gas changes with time after stoping drilling .



The comparison of analysis speed between GC and the pocket GC

Major Achievements

5. Real-time Mud Gas Monitoring

1

Object Task

Realizeing real –time mud gas monitoring.

2

Technological Pain Point

There is no real-time mud gas monitoring for natural gas hydrate drilling in permafrost in China.

3

The major problems solved

The mud gas real-time monitoring was established for gas hydrate drilling in permafrost through creating and modifying software to hardware 。

Major Achievements

5. Real-time Mud Gas Monitoring

The major technique improved

01 The drilling pressure parameter identification was solved for gas hydrate drilling.

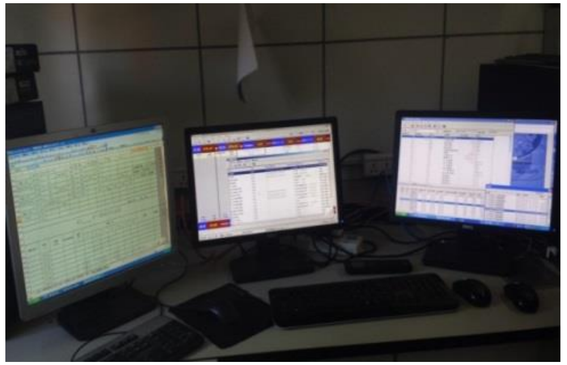
02 Establishing drawworks sensor of the geological drilling rig and realizing well depth measurement

03 Eliminating geological drilling well depth error due to coring twist off

Major Achievements

The major technique improved

The draworks sensor system of geological drilling rig

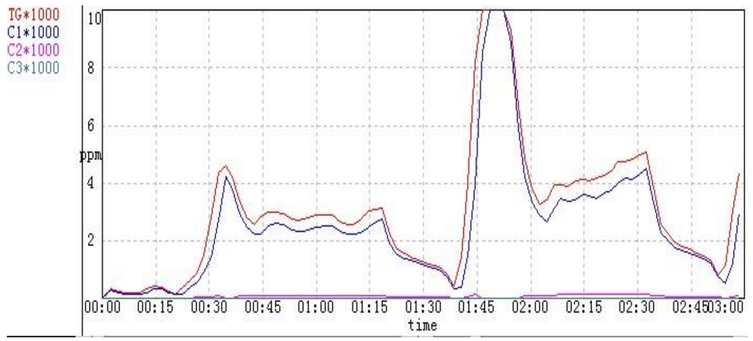


Monitoring indicator display terminal

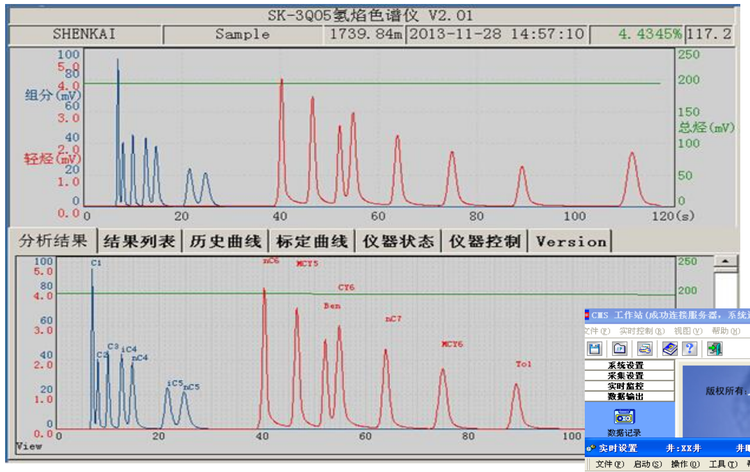
Sensor transmission port

The real-time monitoring control system for mud gas logging

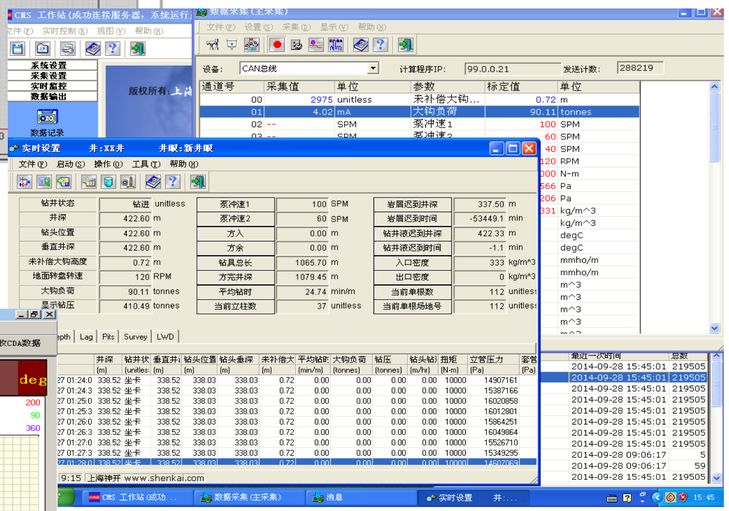
Major Achievements

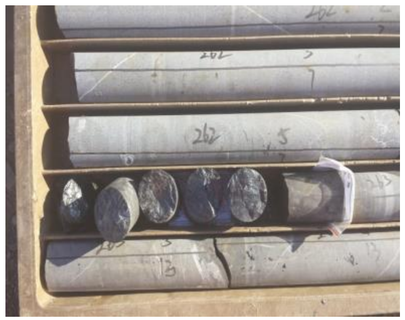


The real-time mud log hydrocarbon chromatogram for 262 round trip of MK-3 Well



C_1-C_5（30s cycle）and C_1-C_8（120scycle） Gas Chromatogram





The rock core

The core gas sample

The real-time monitoring interface Of comprehensive logging instrument

The interfaces of monitoring parameter of comprehensive logging instrument

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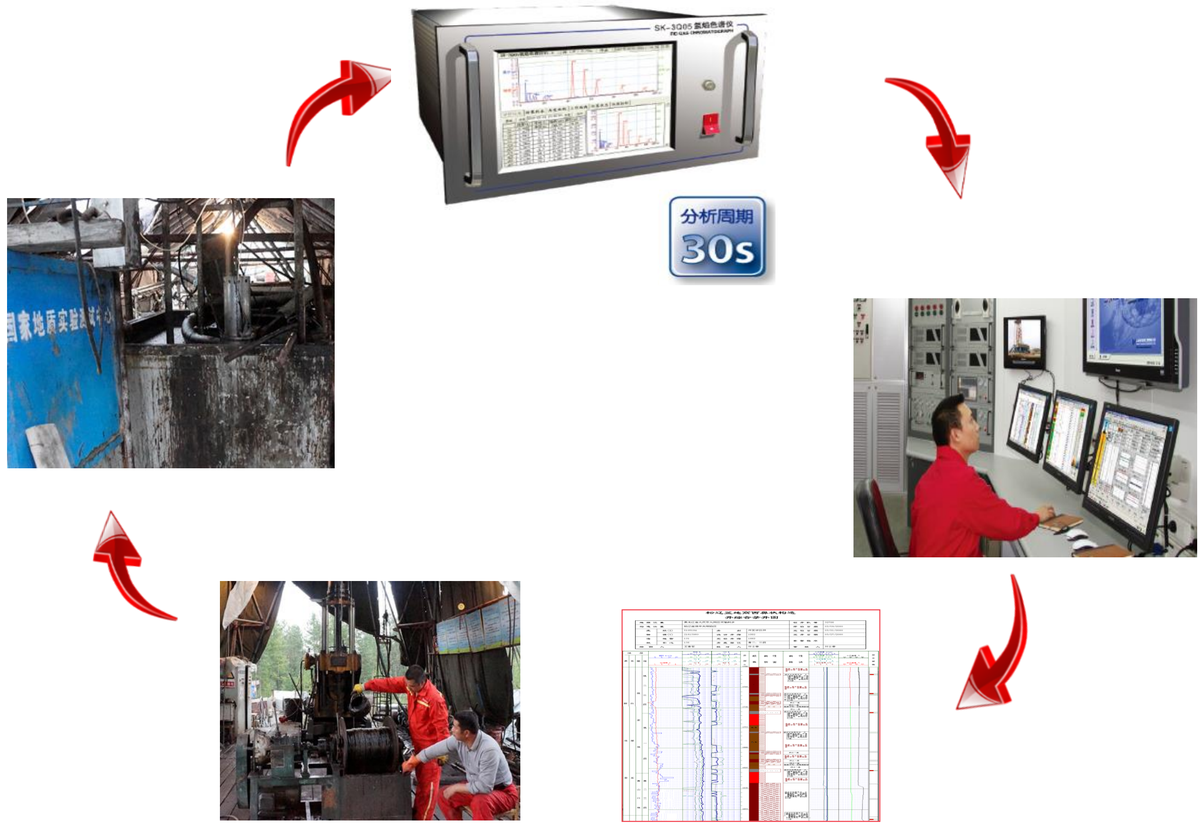
Major Achievements

The features of real-time mud gas Monitoring

A. A fast analysis of the gas of C_1 ~ C_5 in 30's cycle and C_1 ~ C_8 in 120's cycle were realized.

B. The drilling parameters such as drilling time and well depth can be obtained accurately

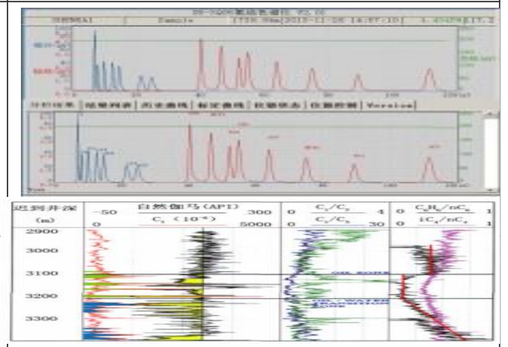
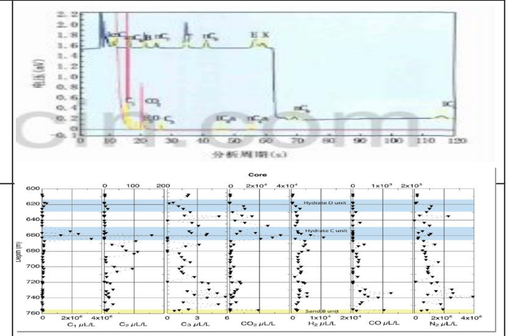
C. The gas anomaly resolution and drilling warning capability are improved.



The flow chart of real time online mud gas monitoring with geological drilling rig

The comparison of testing methods

The comparison of testing methods with the world main gas hydrate survey

Testing Method	Targets	Detection Period	Rock Core Gas	Cutting Gas	The Free Gas	Parameter Diagram
Our testing method	C_1-nC_5	30s	Yes	Yes	Yes	
	C_1-nC_8、benzene,Toluene, cyclopentane, alkane	120s				
US.Schlumberger company Flair	C_1-nC_8,Benzene, methyl cyclohexan	90s	No testing	No testing	No	
US.Weatherford Company GC-Tracer	C_1-nC_8、Benzene	60s	No testing	No testing	No	
USGS Mount Elbert Gas Hydrate Test Well	C_1-nC_5	-	Yes	Yes	Yes	

The national patents obtained

I0 utility model and **I** invention of Chinese were obtained.

荣获

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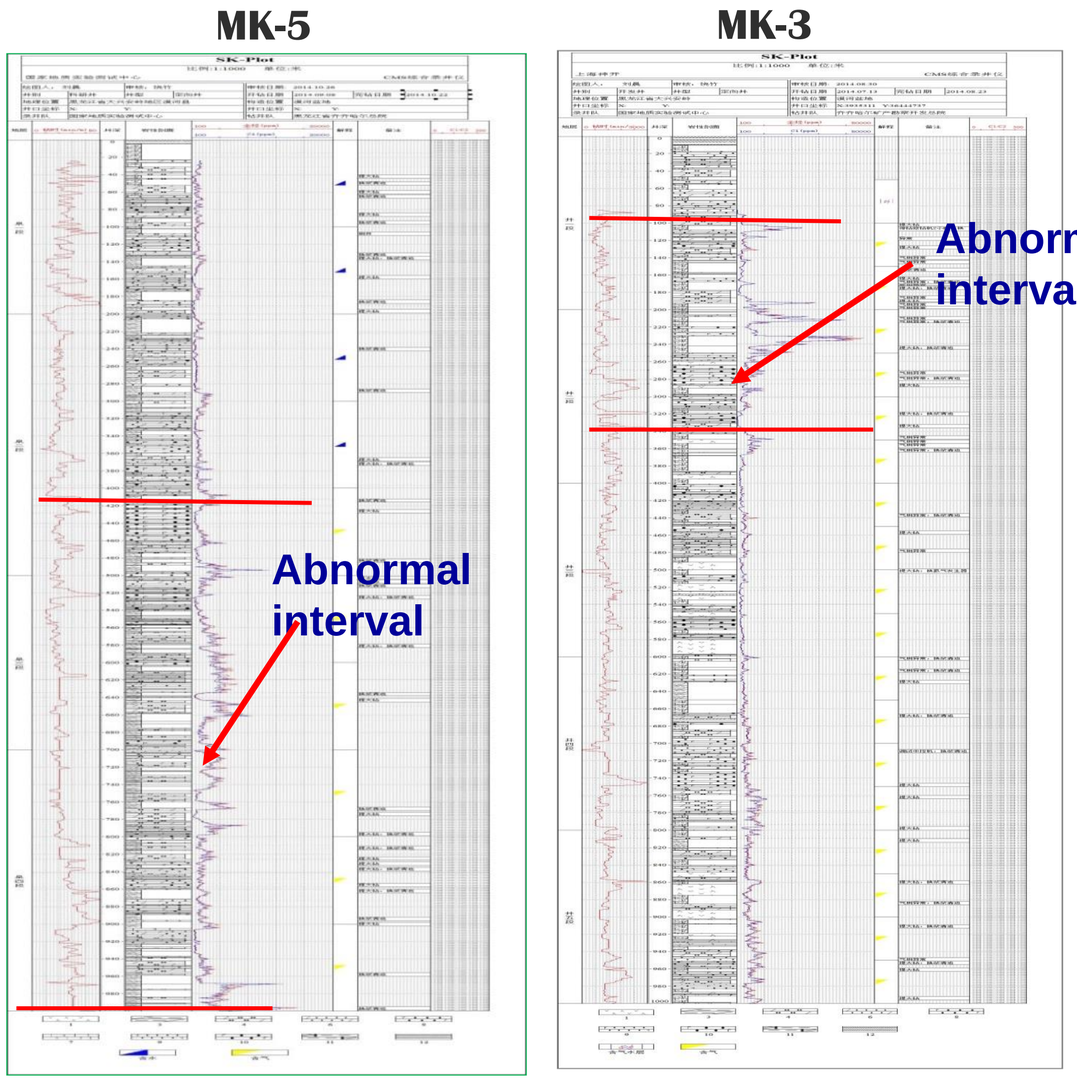
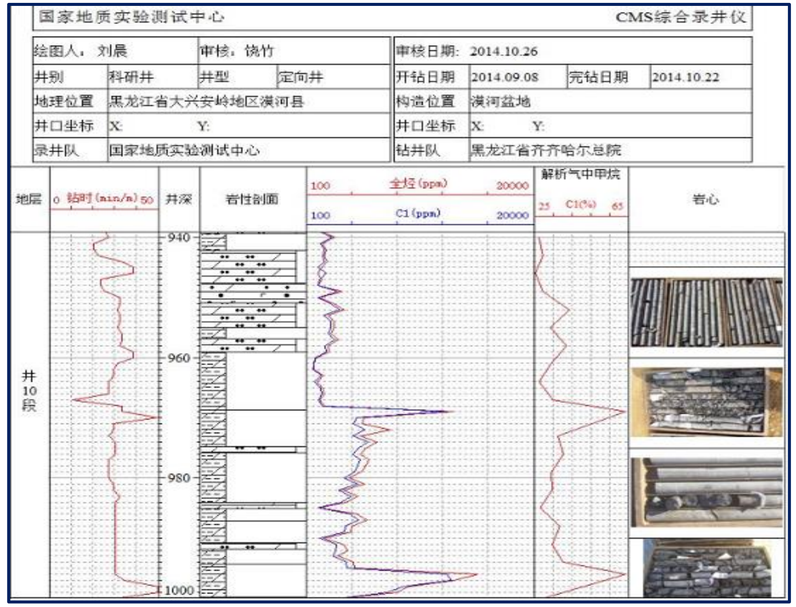
Research Results Application

- The research results were applied to the determination of core gas ,cutting gas and free gas of Mk-3, Mk-4 and Mk-5 gas hydrate drilling wells in Mohe permafrost in Cina.
- It completed real time monitoring of light hydrocarbons

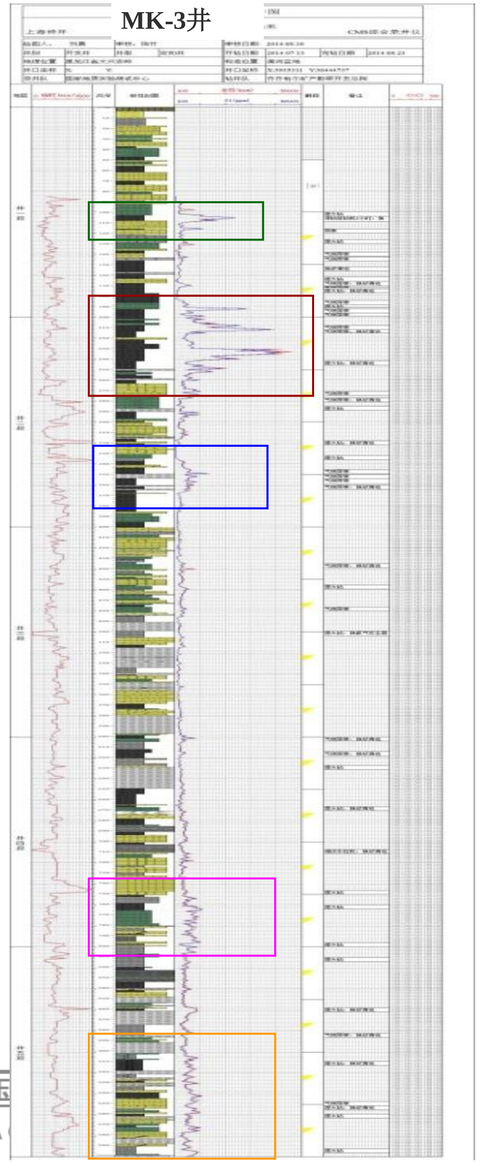


The comprehensive logging diagram for Mohe gas hydrate science drilling mk-3, mk-5

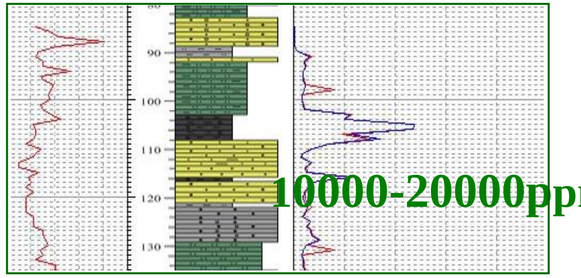
The consistency of detective results of gas logging with core gas for mk-3 well

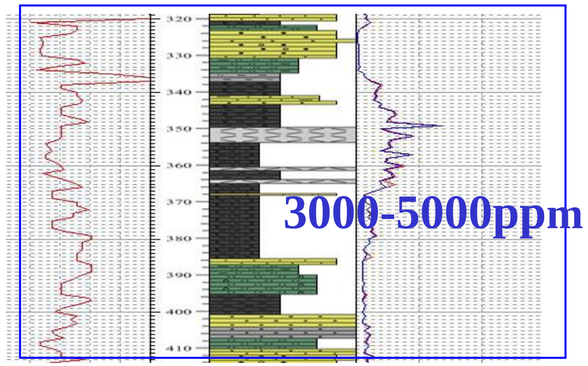


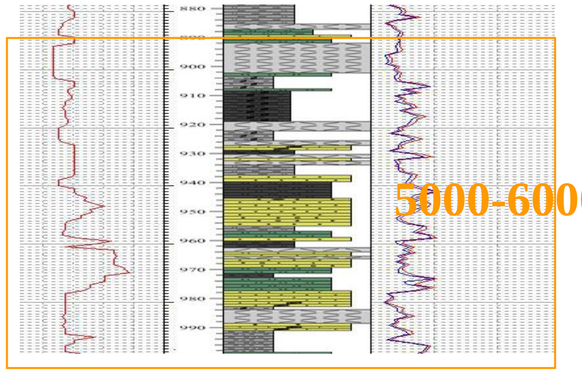
The consistency of abnormal concentration for mud log and gas desorbed of rock core



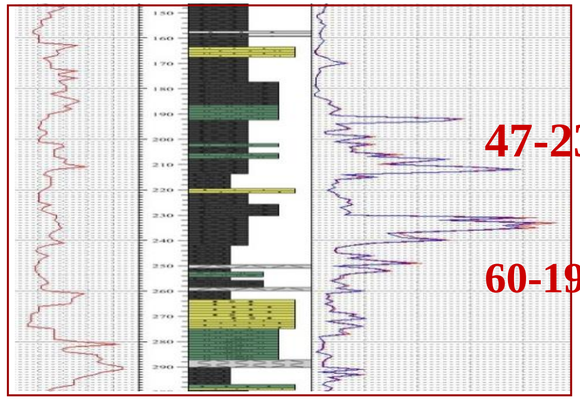
The gas concentration of mud logging

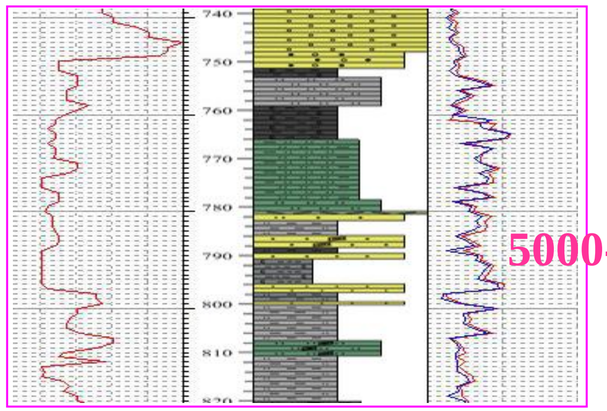






The concentration of core gas





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Research Results Application

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Geochemistry of drill core headspace gases and its significance in ga
hydrate drilling in Qilian Mountain permafrost

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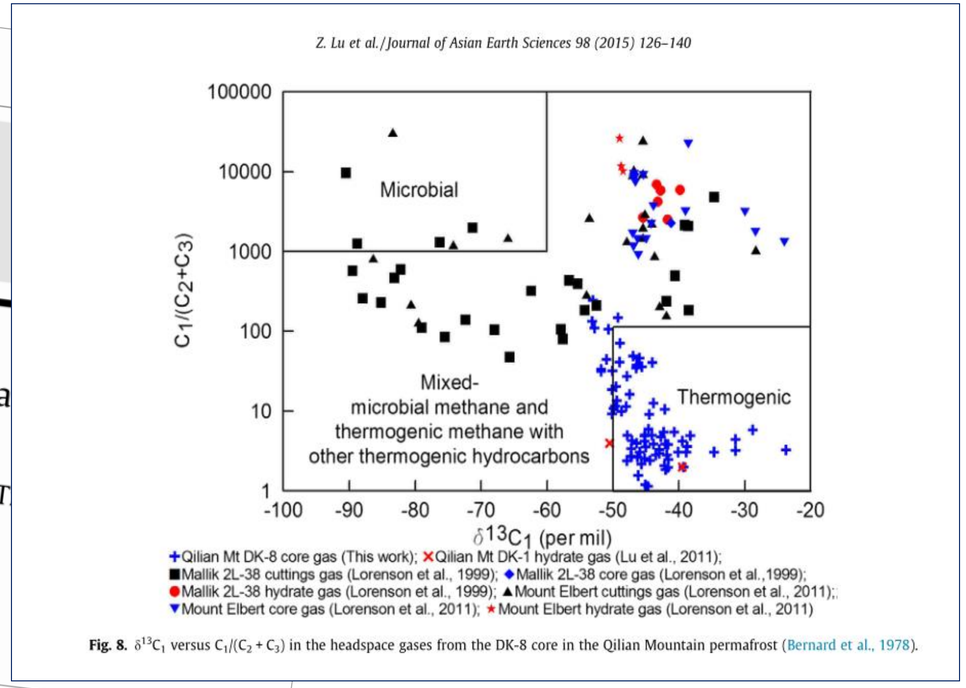
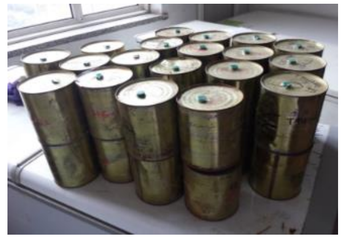


Fig. 8. $\delta^{13}C_1$ versus $C_1/(C_2+C_3)$ in the headspace gases from the DK-8 core in the Qilian Mountain permafrost (Bernard et al., 1978).





The Conclusion

1.The establishment of comprehensive technique for the rapid detection of core gas in gas hydrate drilling field.

2. The mud logging of geological drilling rig has been realized through technical improvements

3. 11 patents for 10 utility model and 1 invention of Chinese were obtained

4. It promotes to the development of rapid detection technology on site.

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