



Overview of gas and oil development on the Yamal Peninsula

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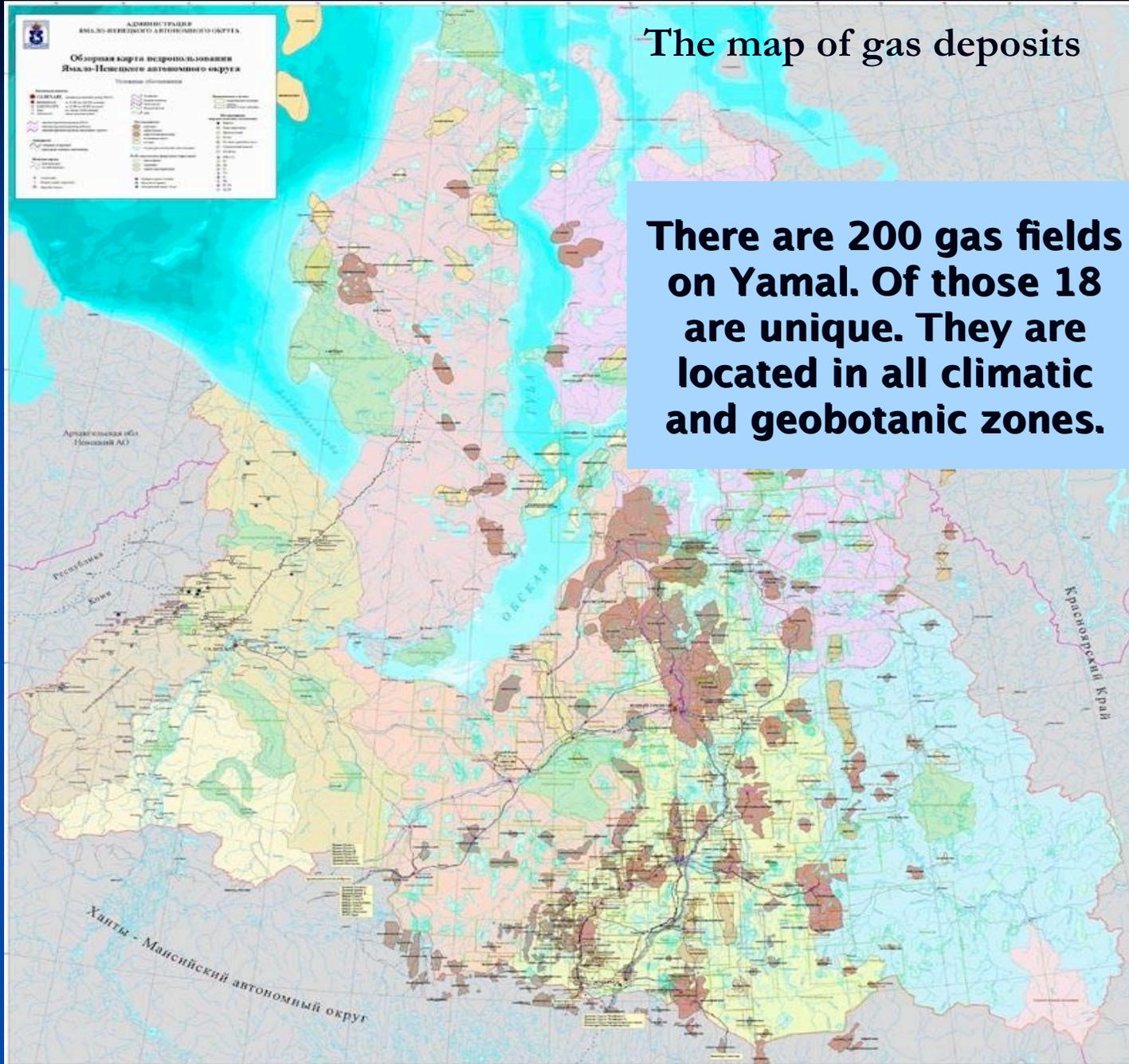
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Problems of Yamal development

- Gas reserves
- Pipeline exploitation
 - Natural processes along the pipeline route
 - Experience of pipeline construction
 - Technogenic processes
 - Protection constructions
- Gas field development
 - Transport pathways
 - Workers dwelling
- Ecological problems
 - Landscape disturbance
 - Nomadic people adaptation

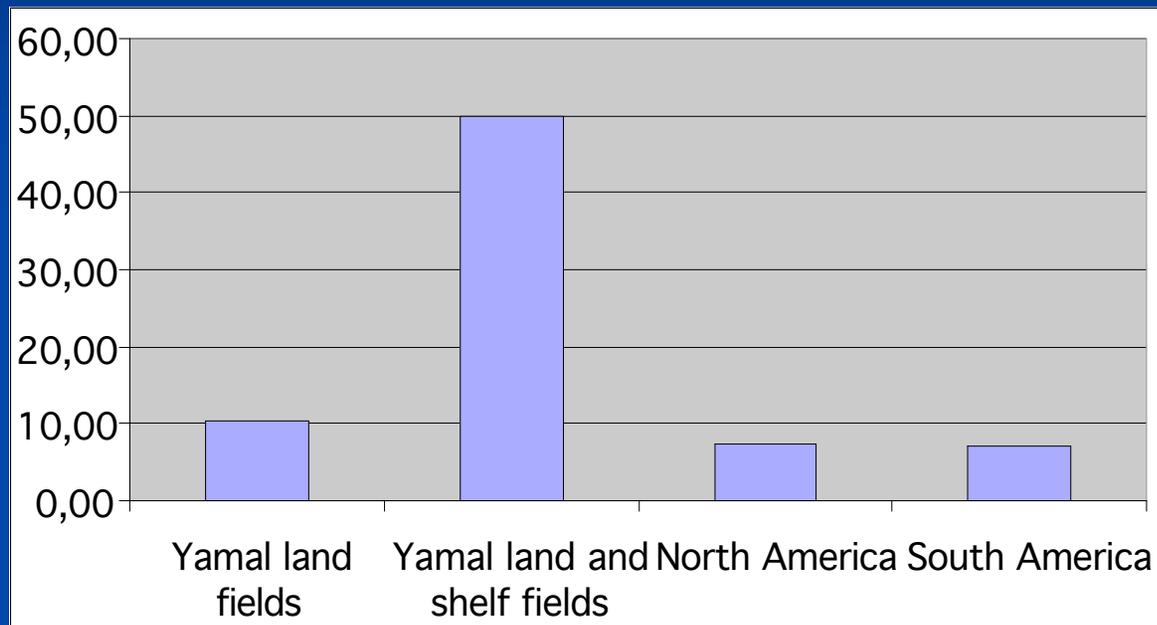
The map of gas deposits

There are 200 gas fields on Yamal. Of those 18 are unique. They are located in all climatic and geobotanic zones.





Gas deposits of Yamal compared to Americas (in trillion m³)



- Yamal gas deposits contain 13.5 trillion m³ of proven gas reserves inland, reaching 50 trillion m³ with additional deposits of the Kara sea shelf. The largest deposits of Yamal: Bovanenkovo, Kharasavey and Novy Port contain 5.8 trillions m³ of gas, 100.2 million tons of gas condensate, and 227 million tons of oil. Proven Yamal reserves are close to that of North American (7.5 trillion m³), and South American (7.1 trillion m³) reserves taken together



- Contemporary Russia's gas production is more than 600 billions m³ of gas which makes up 20% of the world consumption.
- In 2030 gas production on Yamal will be as high as 250 – 260 billions m³/yr.

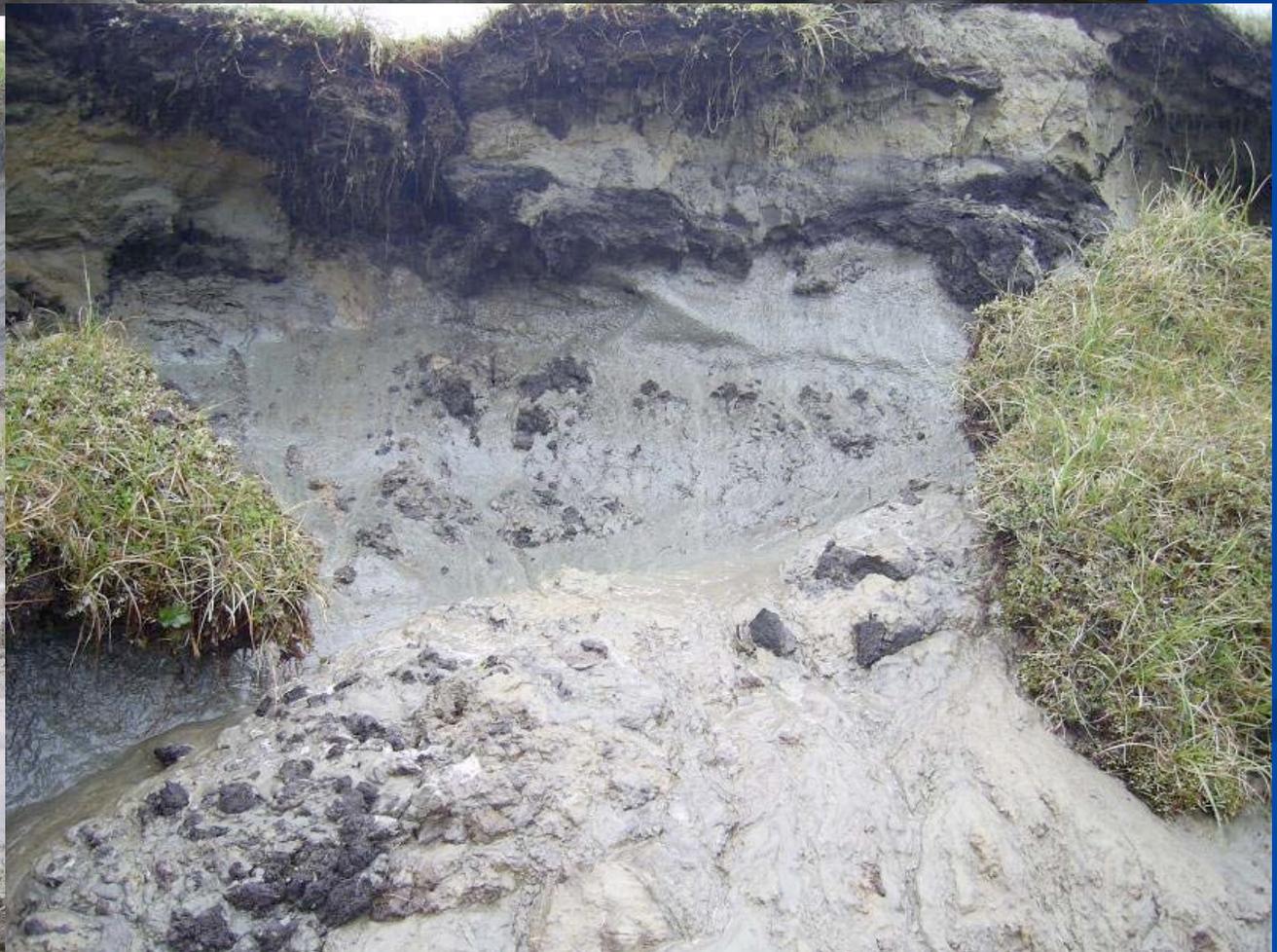
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Cryogenic processes in natural conditions along the route of designed pipeline: thermal denudation



Investigations for construction



Investigations are performed only in winter to preserve natural covers as much as possible. Transport in tundra is not allowed in summer.

Cryogenic processes in natural conditions
along the route of designed pipeline:
lake thermoerosion



Cryogenic processes in natural conditions along the route of designed pipeline: frost heave



Seasonal hummocks



Pingo

Cryogenic processes in natural conditions along the route of designed pipeline: slope processes



Embrional (a landslide body was not evacuated from the shear surface) cryogenic landslide overgrown since 1989 activation



Modern cryogenic landslide on the small pool bank

Cryogenic processes in natural conditions along the route of designed pipeline: thermoerosion



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Methods of minimizing the risks caused by cryogenic processes: experience of pipeline construction and exploiting in forest-tundra



Even in discontinuous permafrost cryogenic processes are activated immensely on the construction sites. In continuous permafrost in tundra, with massive ground ice consequences will be much stronger

Man-induced thermoerosion

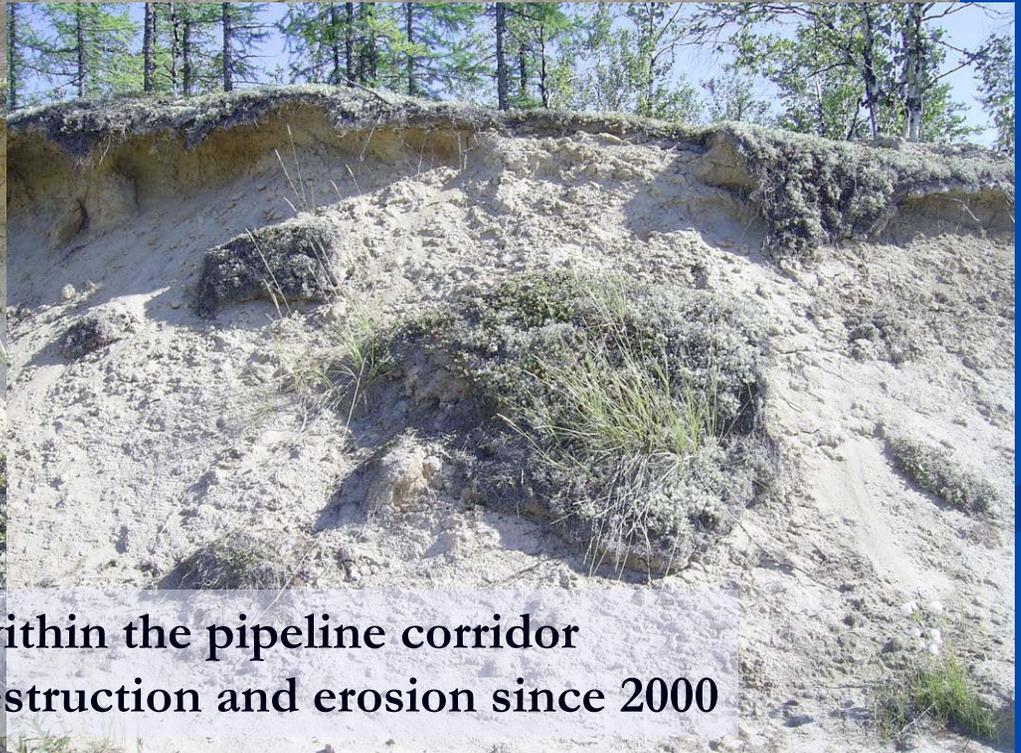


Flooding



Water flowing over the embankment of the pipeline

After 6 years of pipeline exploiting



New territories within the pipeline corridor
get involved in slope destruction and erosion since 2000

After 6 years of pipeline exploiting



The zone of impact extends from initial 40 m to as much as 100-150 m.
Student standing in the upper right corner is 5.8 feet high.

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Instability of constructions



Failure of the concrete constructions



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Obskaya-Bovanenkovo Railway is under construction, crossing forest tundra and tundra subzones on its way



winter roads

- Yamal gas field development needs reliable transport pathways to provide delivery of people and cargo to the construction and production sites. It is planned to open a cargo train operation in 2009 along the route "Obskaya-Bovanenkovo". The passenger train service is due by 2011. There are plans to build the aerodrome and river port in Bovanenkovo settlement. The seaport and fleet of vehicles are expanding in Kharasavey settlement as well. The winter roads will be built on Yamal following a unique technology "Arctic Elephant". The roads will be carrying 26 million tons of cargo for pipeline and production complex

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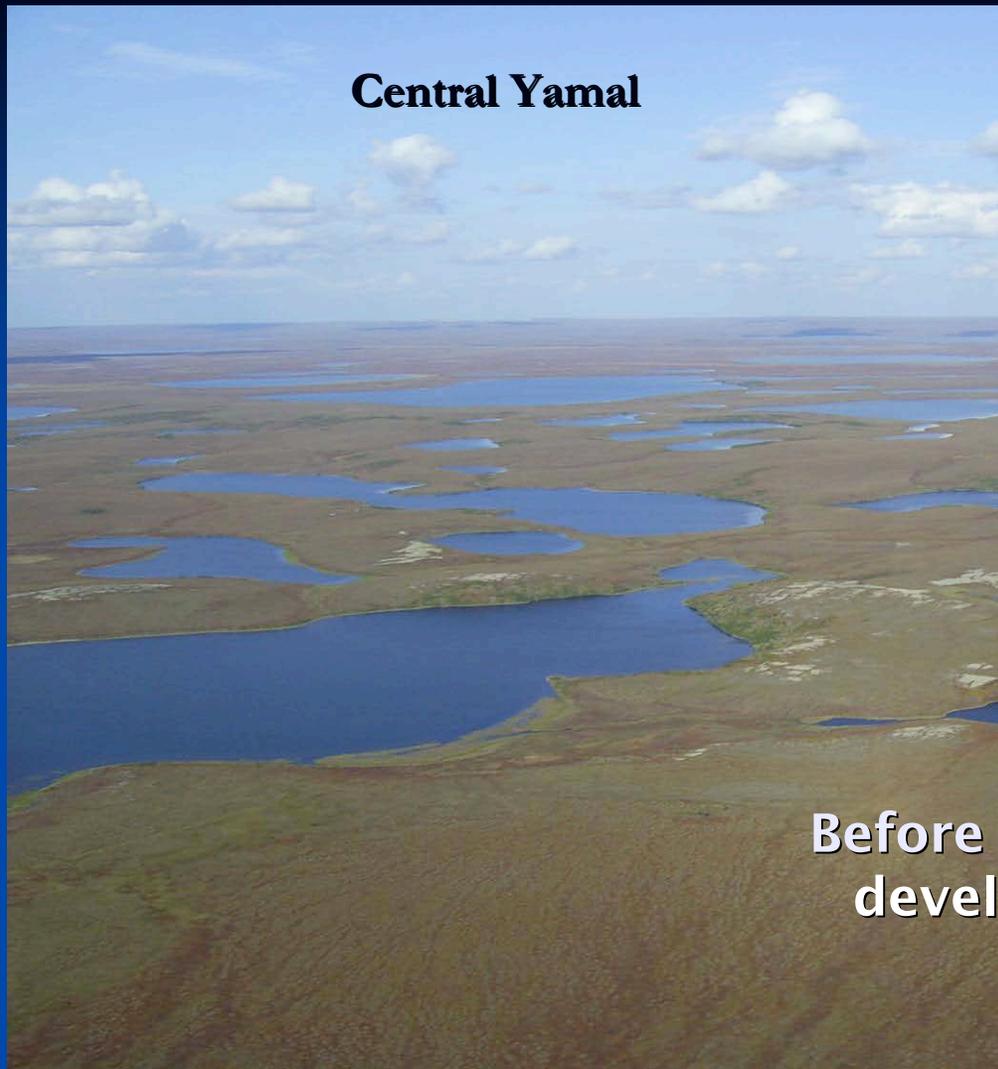
- In 1988 there was only one drilling unit as a single whole with dwelling unit, so that workers can escape severity of climate staying inside the complex.
- Now all the drilling/dwelling units are of the this type
- The same system is employed for construction and exploitation of gas



- Dwelling complexes are delivered to Yamal in assembled (“ready-to-use”) configuration because of severe climate

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Central Yamal



1988

Bovanenkovo

2007

**Before and after
development**

- Gazprom is taking care of the investigation, design and construction to be efficient and comfortable for workers in all possible ways. But still there is a big question of disturbing and remediation of environments and adaptation of local nomadic people.
- The degree of disturbance is increasing every year, especially the area of quarries needed for growing settlements, drilling sites, roads, and

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Nenets people



- It is predicted that 165 families of nomadic Nenets people will move to live in the settlements as a result of reduction of the pastures, and 286 families will have to change the pasture routes for the same reason. Expert estimations are that expenses exceeding several billions dollars are needed to minimize negative impact of development on the human life and disturbed environments by 2011.

Conclusion

- Lots of problems arise while developing Yamal gas deposits.
- Main problems are:
 - Severe climate, and
 - Complicated permafrost conditions: massive ground ice, and active slope processes.
- Extensive damage done to Yamal nature is inevitable. The task is to minimize the damage.

Thank you for your attention