

# GEODYNAMIC AND GEOMECHANICAL HAZARDS AT MAJOR HYDROCARBON FIELD PROJECTS

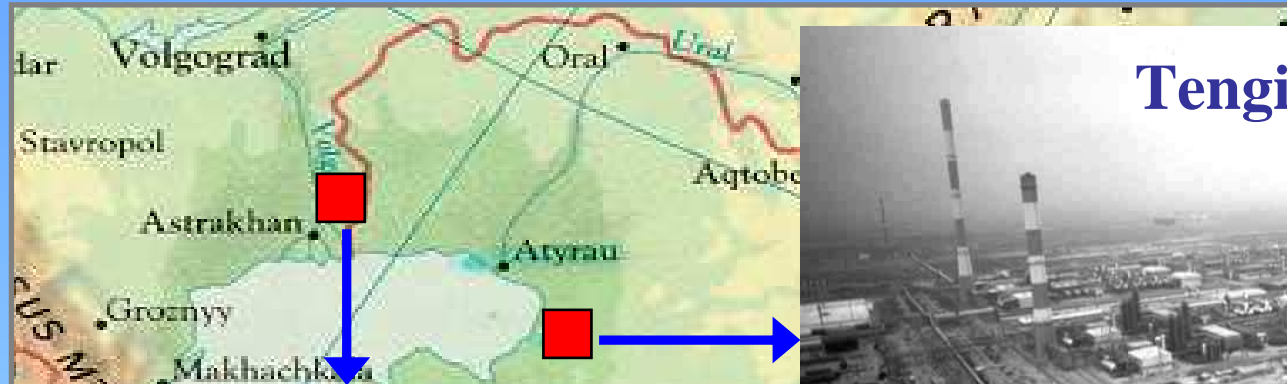
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The report presents data of observations held for many years personally by the authors and some findings by professor Kuzmin U. and V. Sidorov as well as works by the International conference organizing committee “Modern geodynamics of oil-and-gas-bearing basins” (December 6-8, 2005. Organizers are the Institute of oil and gas problems of the Russian Academy of Sciences and the Association of Experts in Oil and Gas Industry, Moscow).

The complex analysis of geodynamic research results in the North Precaspian area is presented for the first time.

## Location of gigantic fields:

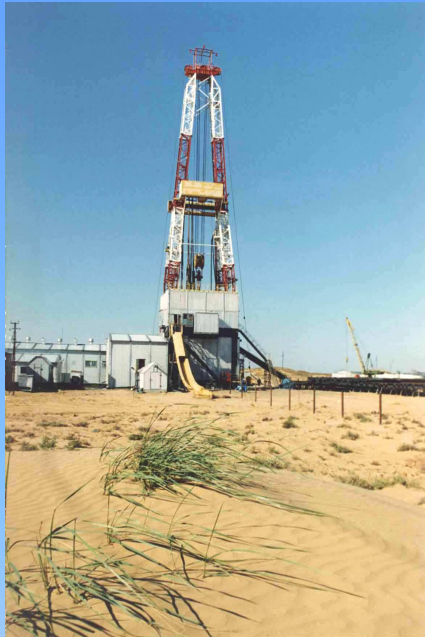


Tengiz field



Astrakhan field





**Astrakhan gas field** was discovered in 1976 in carbonate solid monolith of subsalt palaeozoic containing limestones of Baskir layer of middle carbonate.

Extension of deposits is 100x40 km.

The bedding depth of productive bed top is 3827-3990 m.

The gas column is up to 250 m.

The reservoir temperature is 107C°.

The initial reservoir pressure is 61.2 MPa.

The annual gas output volumes are 12 billion of cubic meters.

**Tengiz lifting** was discovered by exploration seismology in 1976 year.

Petroleum deposit was discovered by drilling in 1979 year.

The initial formation pressure at the depth of 4600 m is 82 MPa.

The current oil flow rate is 400-800 t/day up to 1500 t/day.

The top of oil horizon (petroleum deposit) is 3890 meters.

The magnitude of production interval is nearly 1300 meters.

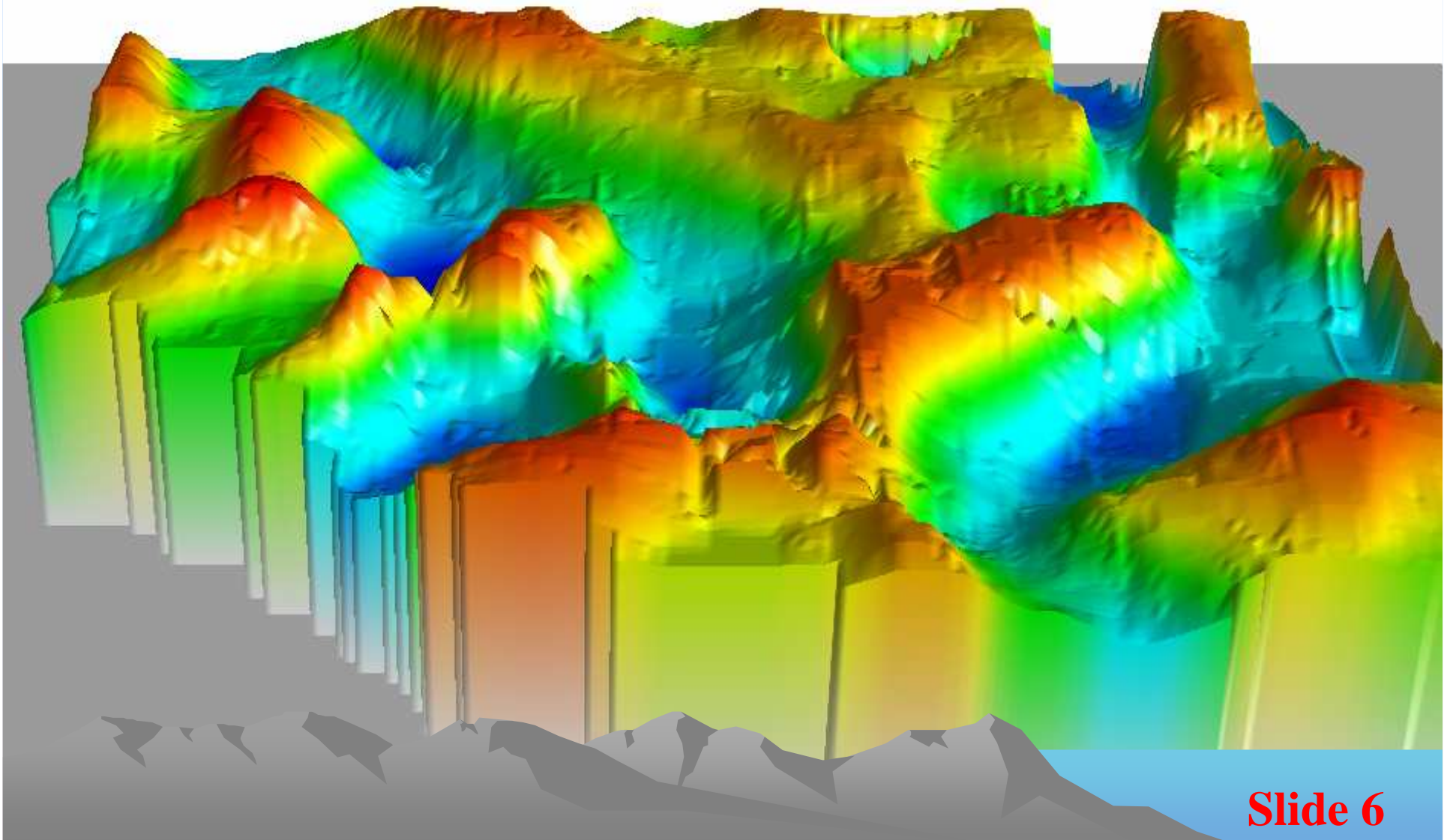
The extracted petroleum reserves are 750-1125 million of tons.

For the time being one can speak with a different degree of probability about six most important natural technogenic factors given below which can take place at the territory of the Astrakhan gas and condensate field and are also typical for the other giant - Tengviz oil field:

- current activity of faults and block structure of geological environment;
- technogenic and/or natural technogenic (induced) seismic activity;
- unequal quasi-stationary stress field of rock massif;
- thick salt-bearing section with complicated surface morphometry practically fully overlying top of a reservoir;
- abnormally high reservoir pressure and high content of hydrogen sulphide in reservoir fluid;
- technogenic load on the environment which will gradually increase with time as product is recovered from subsurface.

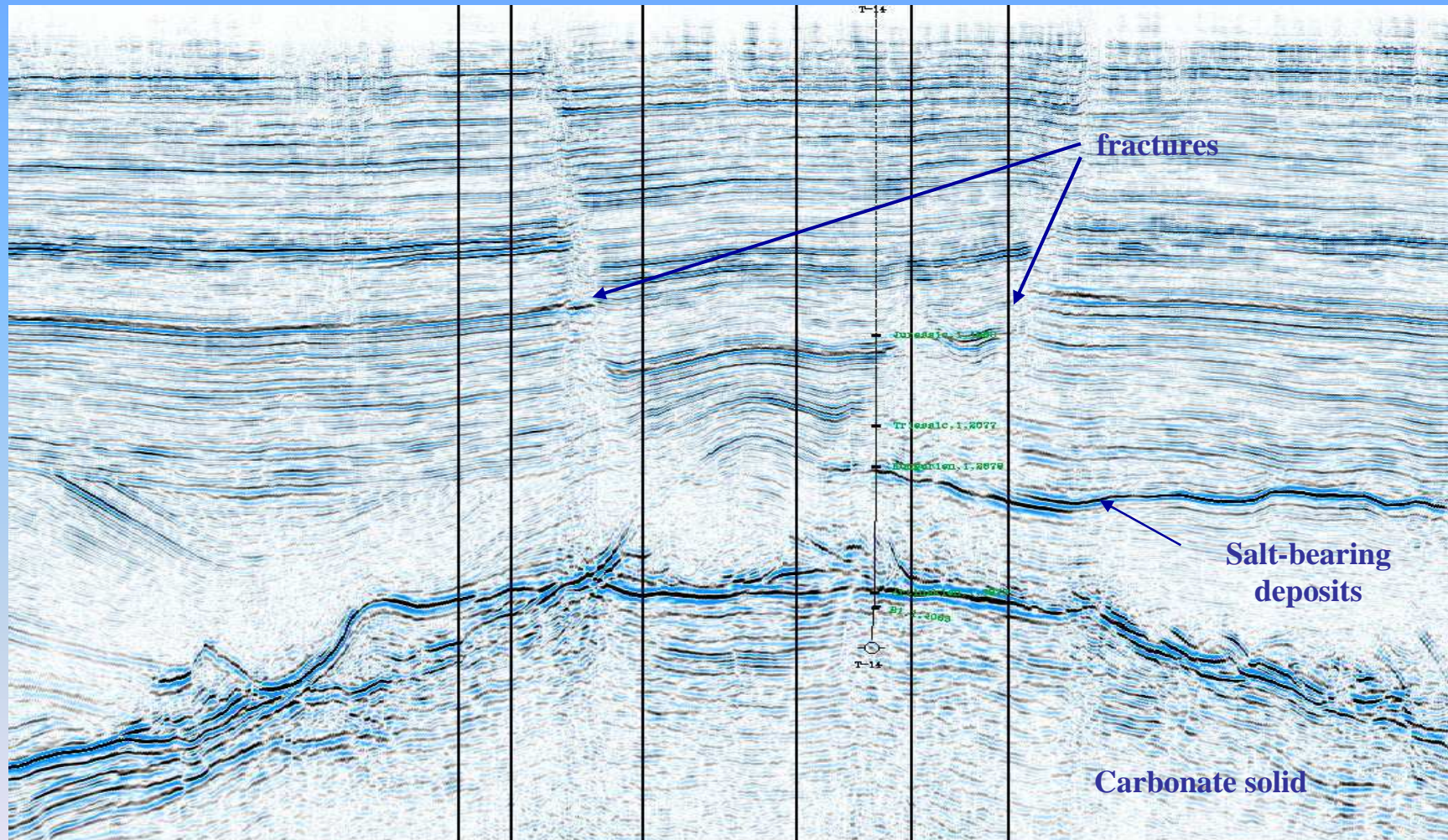


Complicated morphometric surface structure of salt deposits overlying the production reservoir at Astrakhan gas condensate field

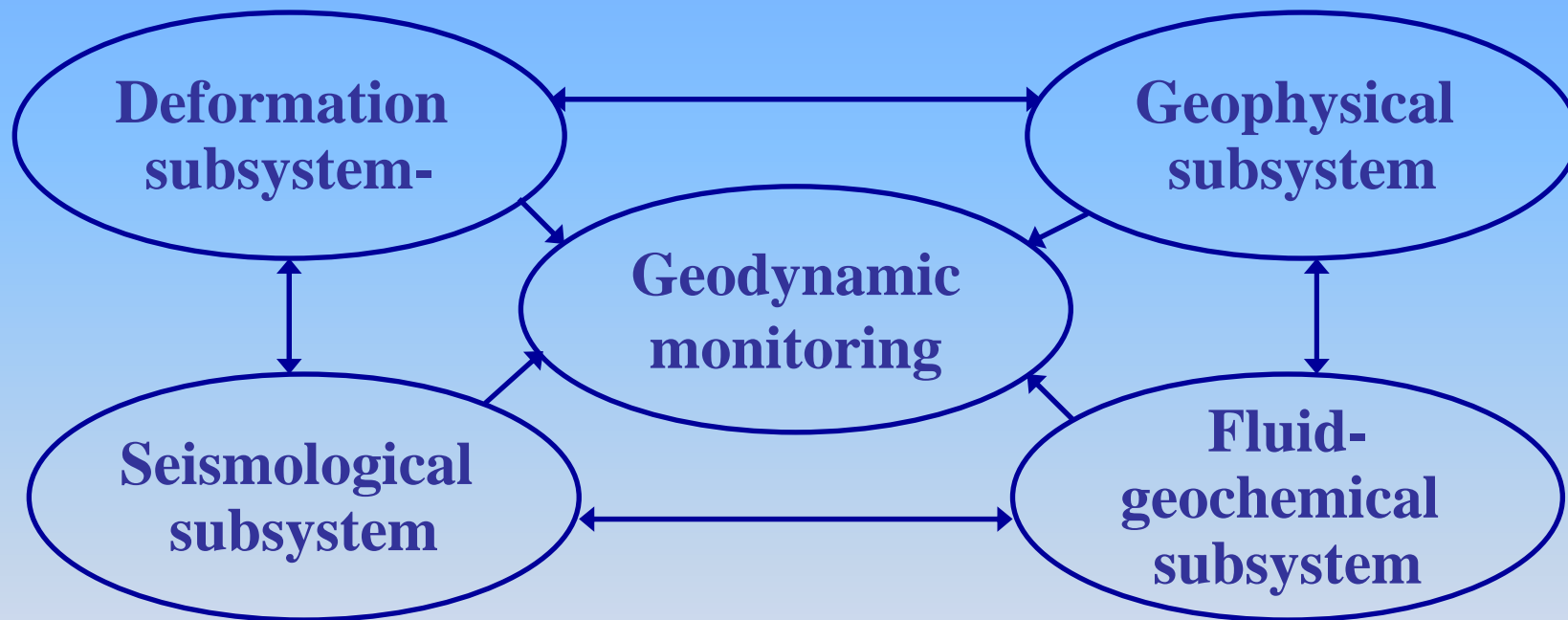




# Standard temporal seismic cross-section through Tengiz oil field



## Geodynamic monitoring system



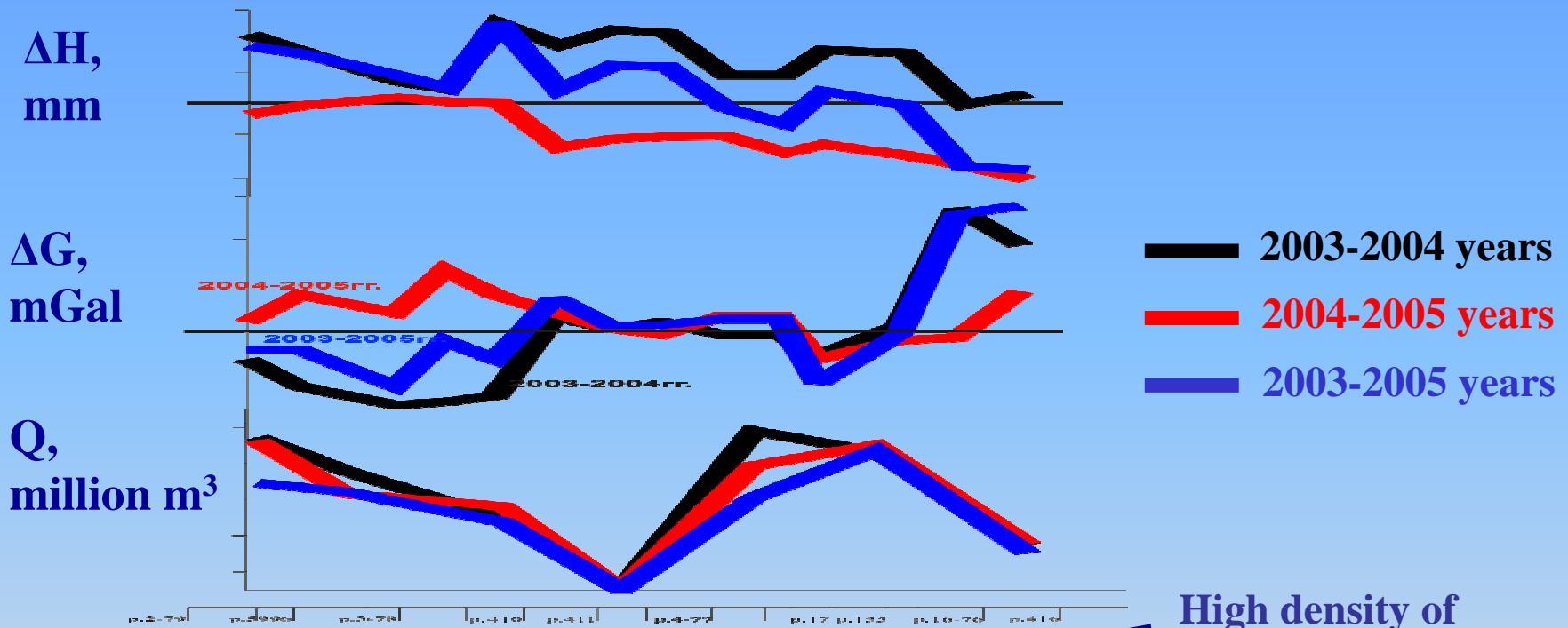


**The following methods of control are used at the test field:**

- ✓ repeated observations by means of GPS-receivers to control horizontal normal movements and deformations,
- ✓ repeated levelling to analyze subsidence of surface,
- ✓ repeated precise surface gravimetric observations,
- ✓ investigation of seismic activity and seismic regime with recording local seismic occurrences,
- ✓ control of fluiddynamic (migrating) processes.

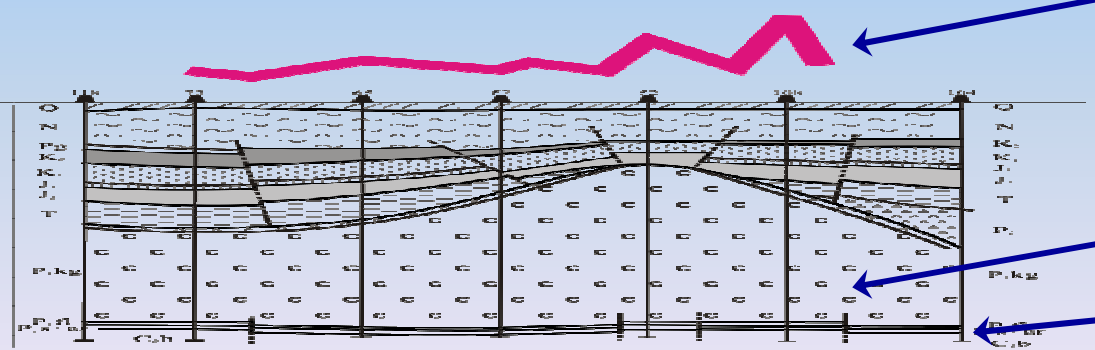


## Research results at Astrakhan test field



- 2003-2004 years
- 2004-2005 years
- 2003-2005 years

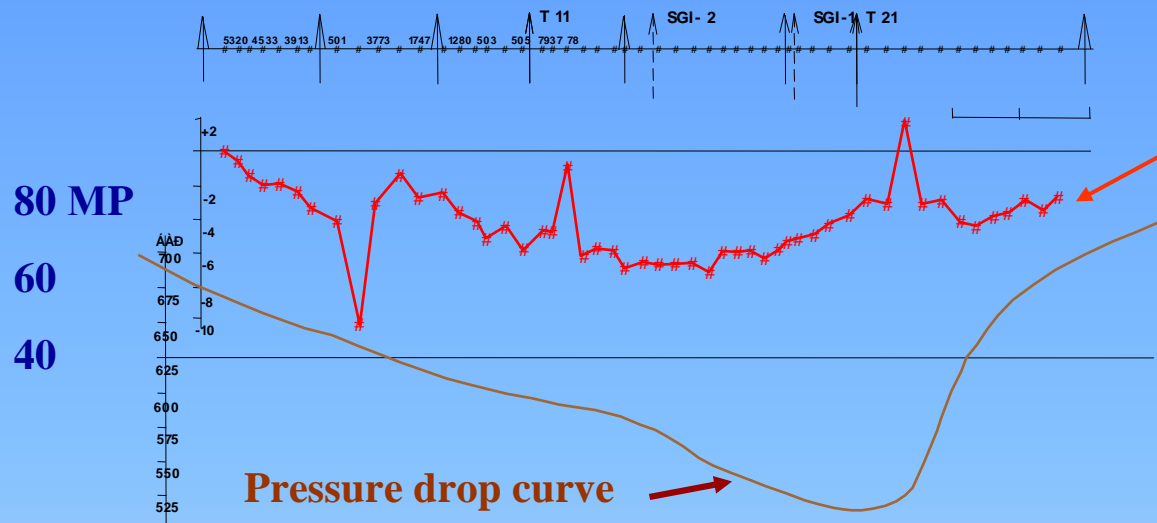
Rn,  
Bk/m<sup>3</sup>



High density of radon flow above active fractures

Salt dome

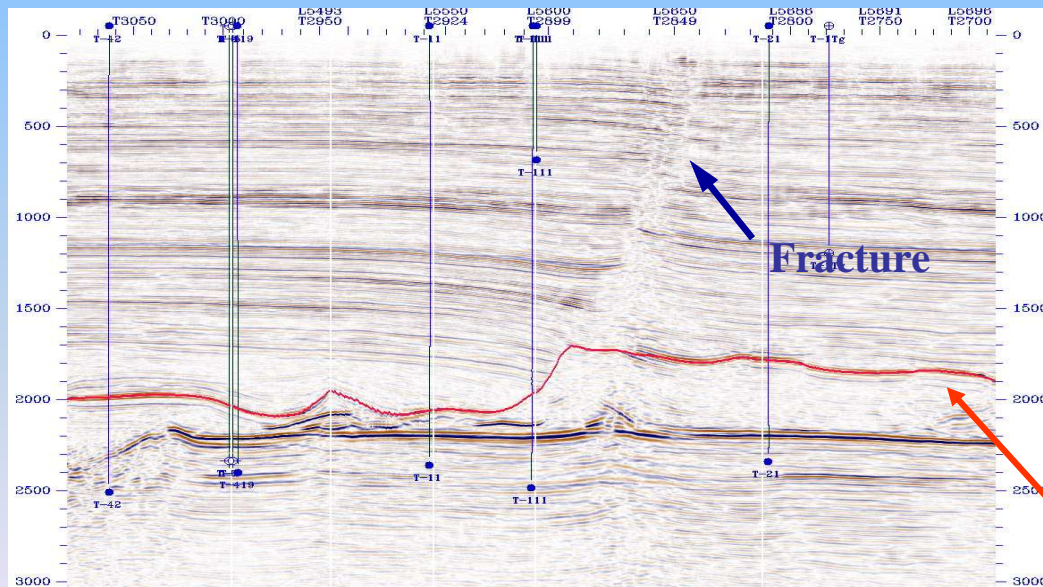
Production reservoir



Pressure drop curve

Vertical movements of surface (Tengiz)

According to data obtained by means of deformation researches at zone with long exploitation and low stratal pressure, vertical shift rates within the period 1999-2000 totaled 4mm per year, and within the period 2003-2004 totaled 5÷7mm per year. In that period under GPS-observations with equal asterisms of satellites in zones which are close to tectonic disturbance, the horizontal shift rate totaled 9÷11mm per year and 16÷19mm per year (Astrakhan gas condensate field).

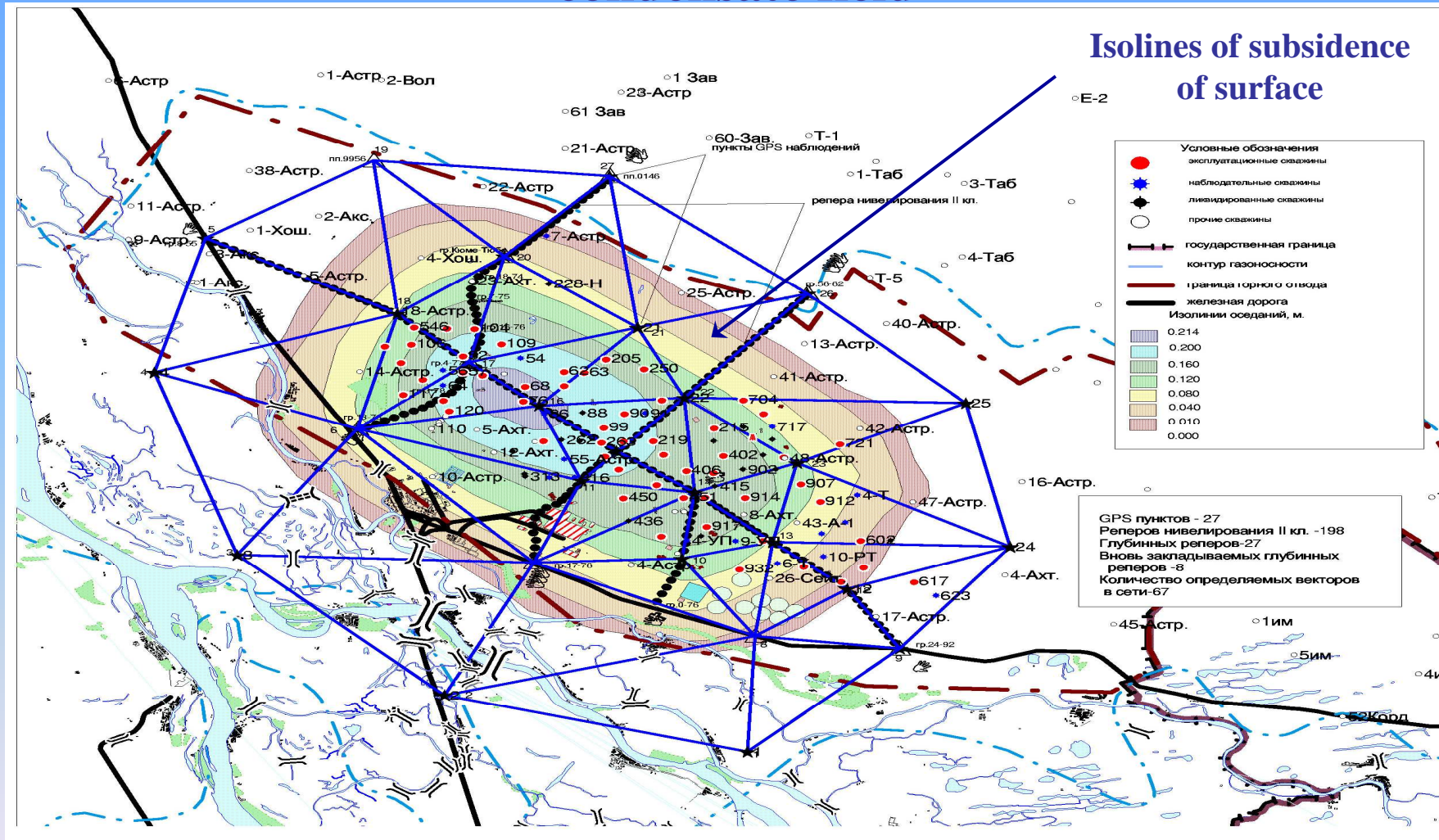


Fracture

Saline deposits surface



# Principal diagram of geodynamic test area of Astrakhan gas condensate field



**The main idea** is that not a single oil and gas deposit being in operation for a long period of time can be secured from geodynamic occurrences just for the reason of recovering significant masses of fluid from the subsurface and as a result of it disturbing originally balanced stressed condition. With all this going on combined manifestation of occurrences takes place as a rule. Seismic activity may be accompanied by activation of faults, subsidence of surface with horizontal slip of rock. The most commonly encountered factor of hazard is strong current deformation processes in the areas of active faults. Thus our researches and found characteristics of deformation processes make it possible to use considerable material to prognose possible unfavorable occurrences on huge deposits of the North Caspian shelf. It aids to plan decrease of geodynamic and geomechanic risks in this biologically unique region.