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future's
in the making

GAOS MS:
Mud logging

GAOS MS-20-7
TOF-MS for mud logging

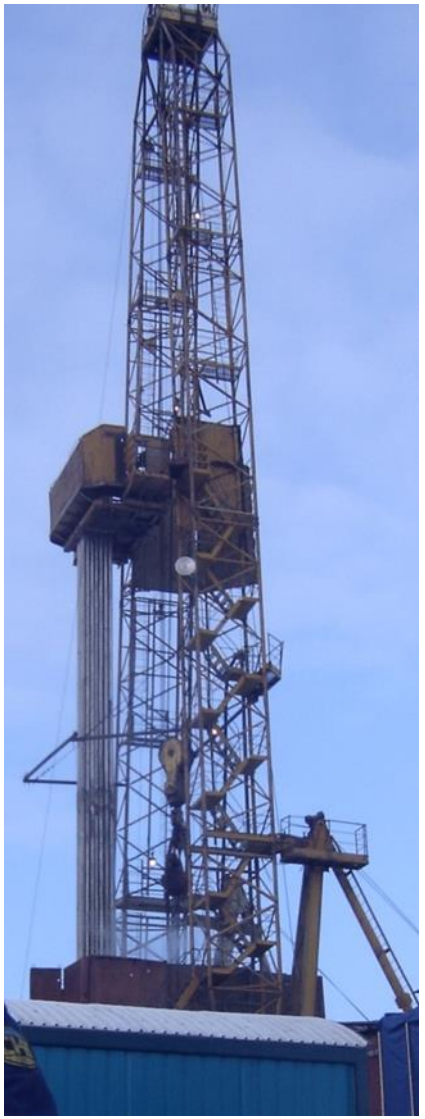
Mud logging

Mud logging – method of qualitative and semi-quantitative gas analysis in mud during drilling or from selected samples.

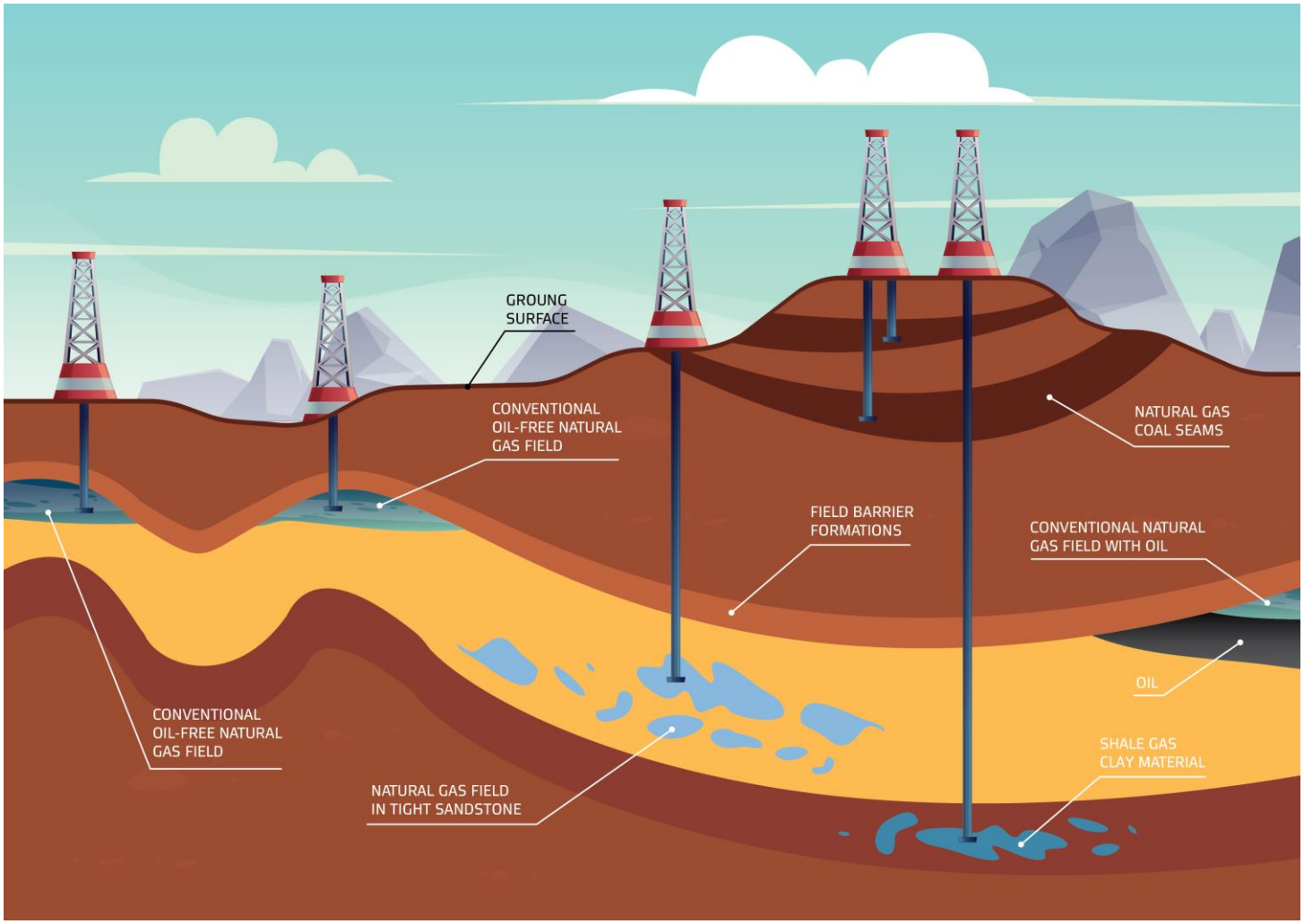
This method gives direct information about parameters of oil and gas reservoirs and other geological objects in well.

Modern technologies of well construction, including high-speed drilling (> 50 m/hour), horizontal drilling, geological investigation in drilling require more data from mud gas analysis:

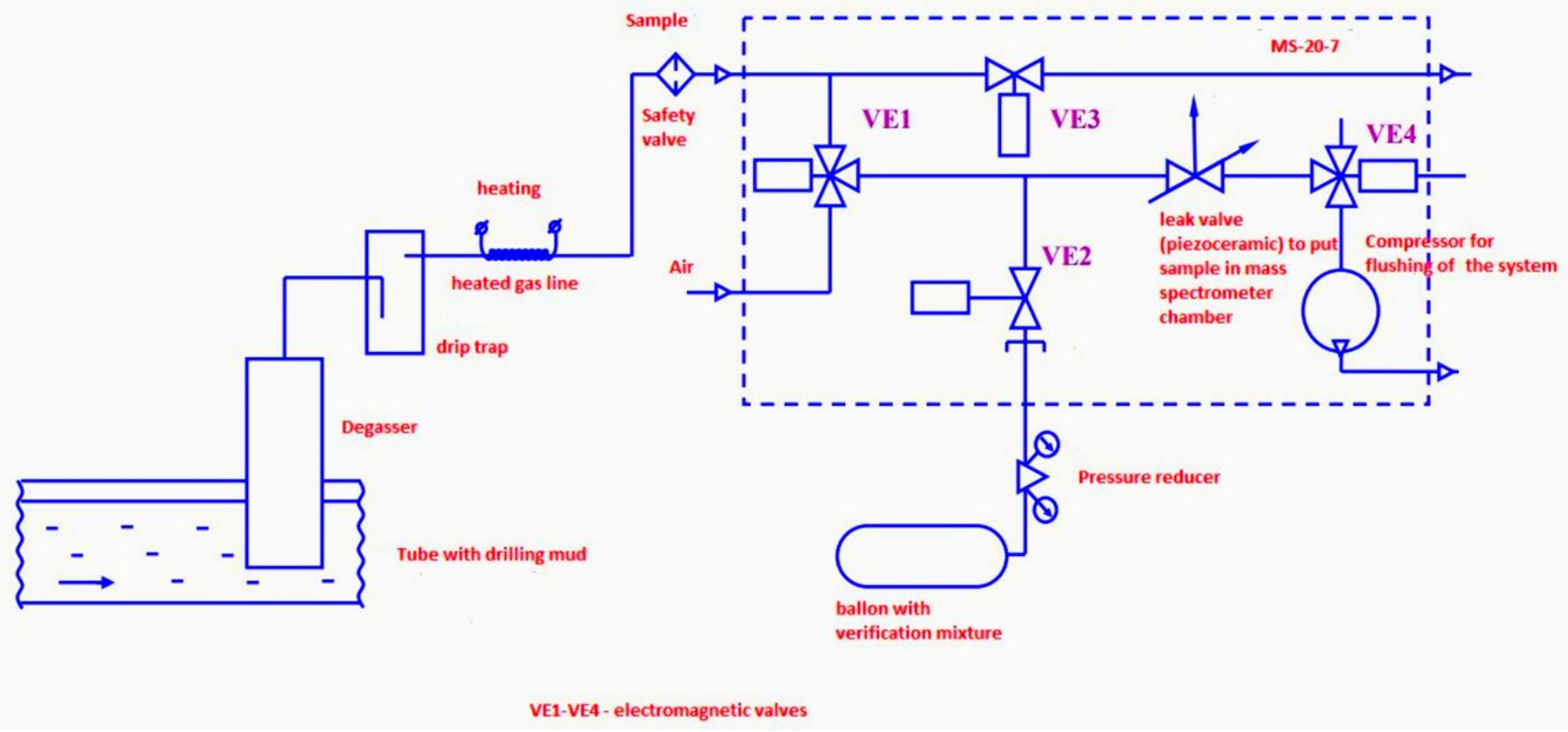
- number of components
- concentration range
- speed of analysis



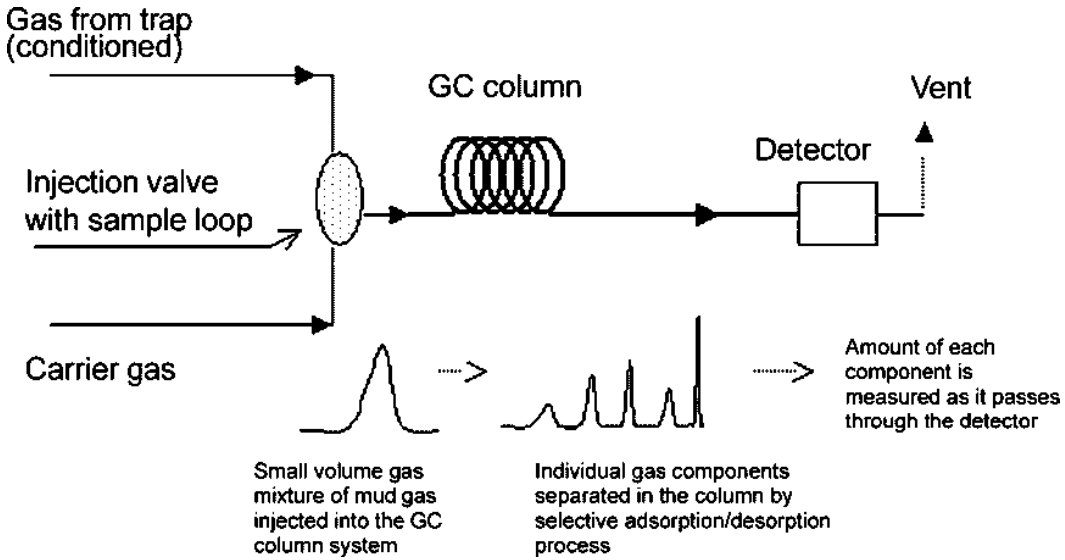
Mud logging
Different geology – different gas composition



Mud logging
Gas scheme



Gas analysis
Gas Chromatography



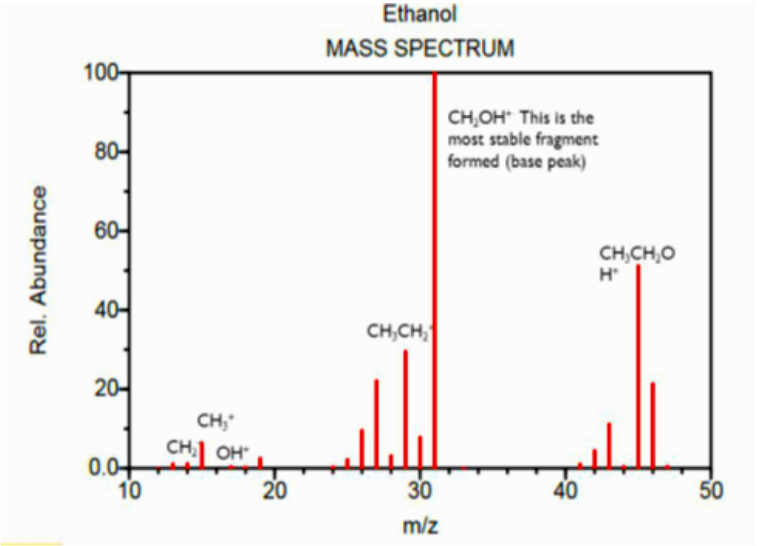
Advantages	Disadvantages
• Accuracy • Reliability • Sensitivity	• Speed of analysis (2 minutes) • No isotope analysis (if not GC-MS)

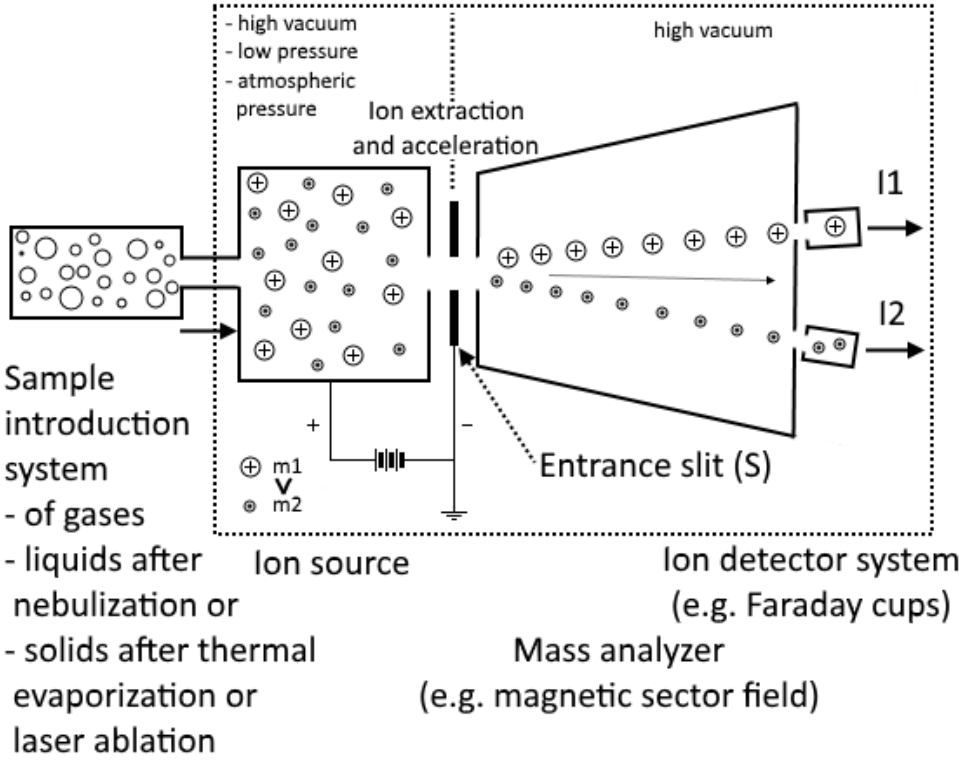
The most widely used technique is Gas Chromatography. This instrument separates components from a mixture by selectively adsorbing and desorbing each compound at different rates. Components start to separate, depending on their affinity for the active surface of the packing or the column tubing. At the end of the column, components elute, each with a unique retention time, and pass into a detector. The different detectors used to analyze the compounds eluting from the GC column include the FID, the TCD, the catalytic combustion detector (CCD), the MS detector, and the infrared (IR) absorption spectrometer.

PetroWiki

Gas Analysis
Mass Spectrometry

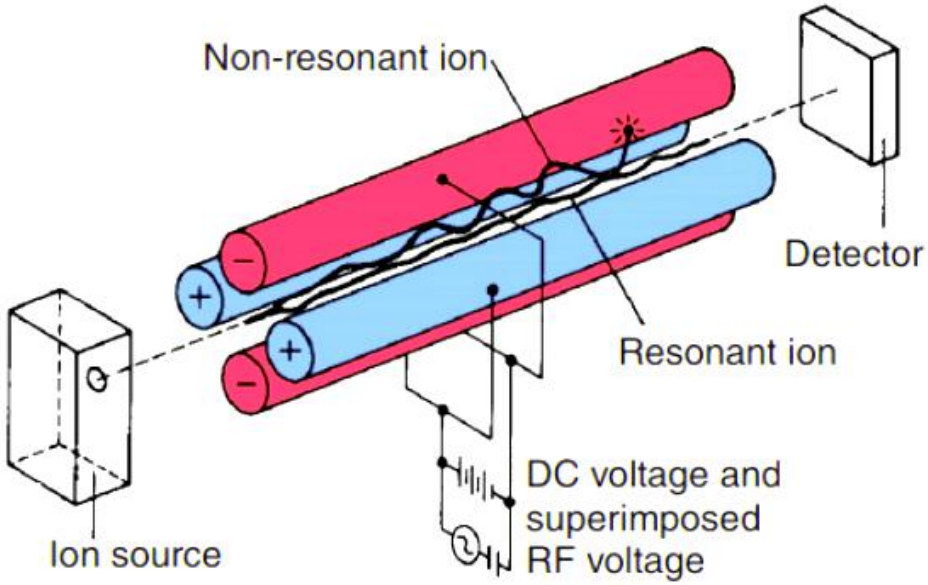
Mass spectrometry (MS) is an analytical technique that measures the mass-to-charge ratio of ions. The results are typically presented as a mass spectrum, a plot of intensity as a function of the mass-to-charge ratio. Mass spectrometry is used in many different fields and is applied to pure samples as well as complex mixtures.





A mass spectrum is a plot of the ion signal as a function of the mass-to-charge ratio. These spectra are used to determine the elemental or isotopic signature of a sample, the masses of particles and of molecules, and to elucidate the chemical identity or structure of molecules and other chemical compounds.

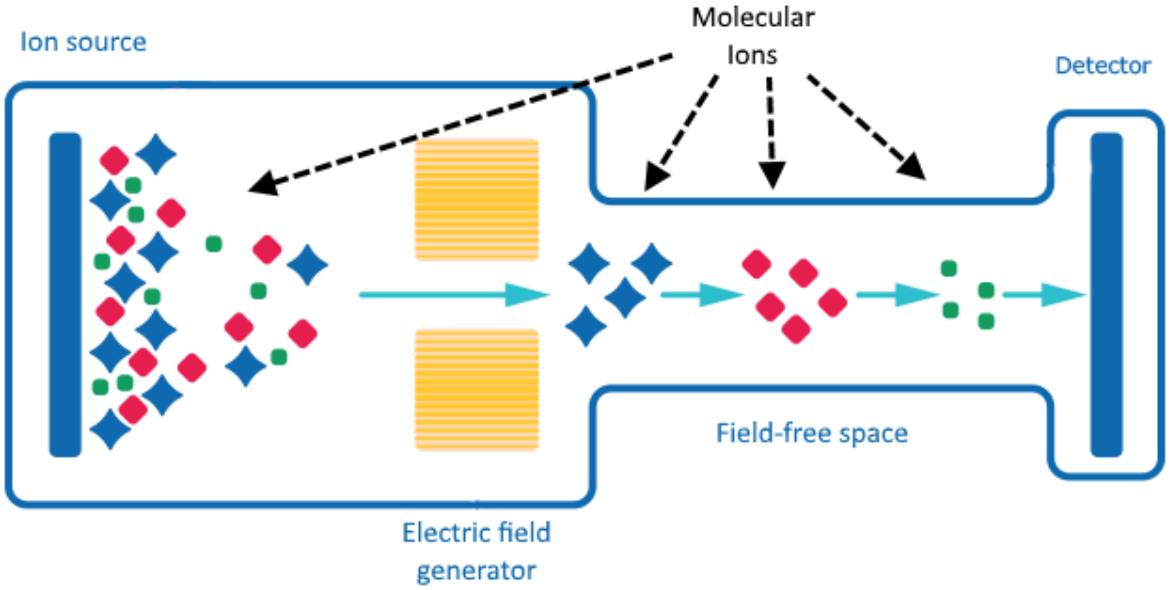
Gas Analysis
Quadrupole Mass Spectrometry



Quadrupole mass analyzers use oscillating electrical fields to selectively stabilize or destabilize the paths of ions passing through a radio frequency (RF) quadrupole field created between 4 parallel rods. Only the ions in a certain range of mass/charge ratio are passed through the system at any time, but changes to the potentials on the rods allow a wide range of m/z values to be swept rapidly, either continuously or in a succession of discrete hops.

Advantages	Disadvantages
- High sensitivity	- Worse precision at low mass - Low limit of upper registered masses - Sensitivity to mechanical impact and electrode deterioration - Sequential analysis

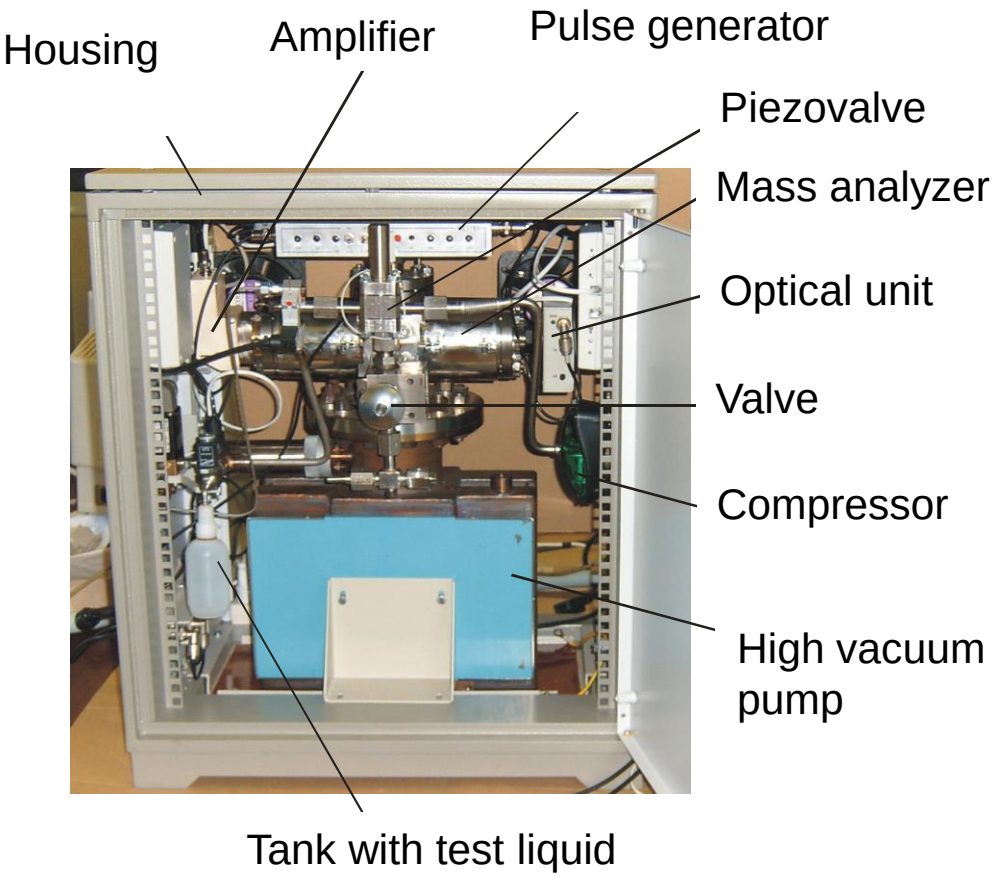
Gas Analysis
Time-of-Flight Mass Spectrometry



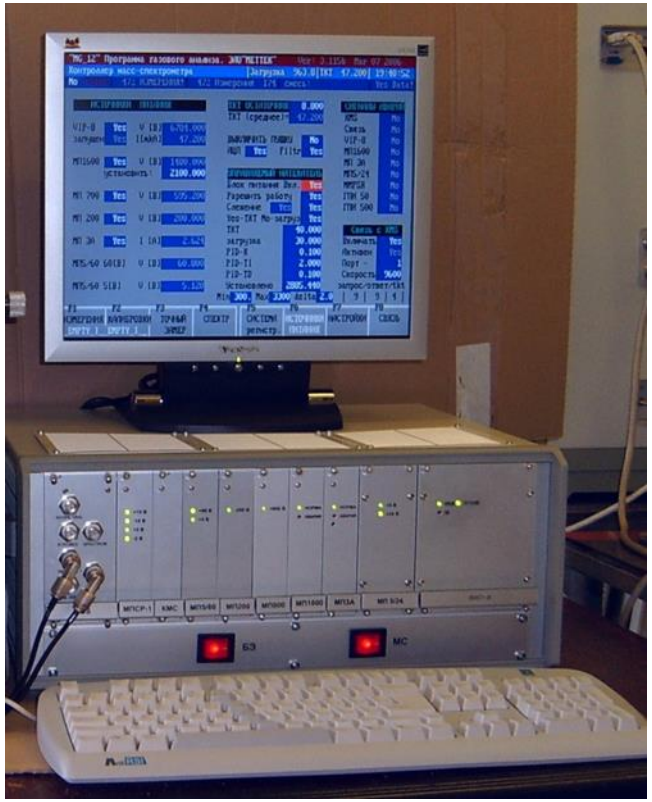
In time-of-flight (TOF) analyzer one measures time of drift in field-free volume.

Advantages	Disadvantages
- Resolution - High limit of upper registered masses - Low sensitivity to accident mechanical impact and internal surface deterioration - Simple algorithm of peak identification - Parallel measurement (analysis time of all components– about 1 s)	- Worse sensitivity (to QMS)

GAOS MS-20-7
TOF-MS for Mud logging



Analytical unit



Electronic unit

GAOS MS-20-7
TOF-MS for Mud logging

GAOS MS-20-7
Analytical parameters

Parameters	Value
Range of masses, Da	1-200
Resolution, M/ΔM	200
Registration channels - Analogue - Counter	 16 16
Analyzed components	CH_4, C_2H_6, C_3H_8, i-C_4H_{10}, C_4H_{10}, C_5H_{12}, C_6H_{14}, H_2, He, N_2, Ar, O_2, CO_2, H_2S, SO_2
Analysis time, no more than, s	2
Dynamic range, % vol.	10^{-4}-100%
Calibration	Automatic
Base line correction	Automatic

GAOS MS-20-7
Design

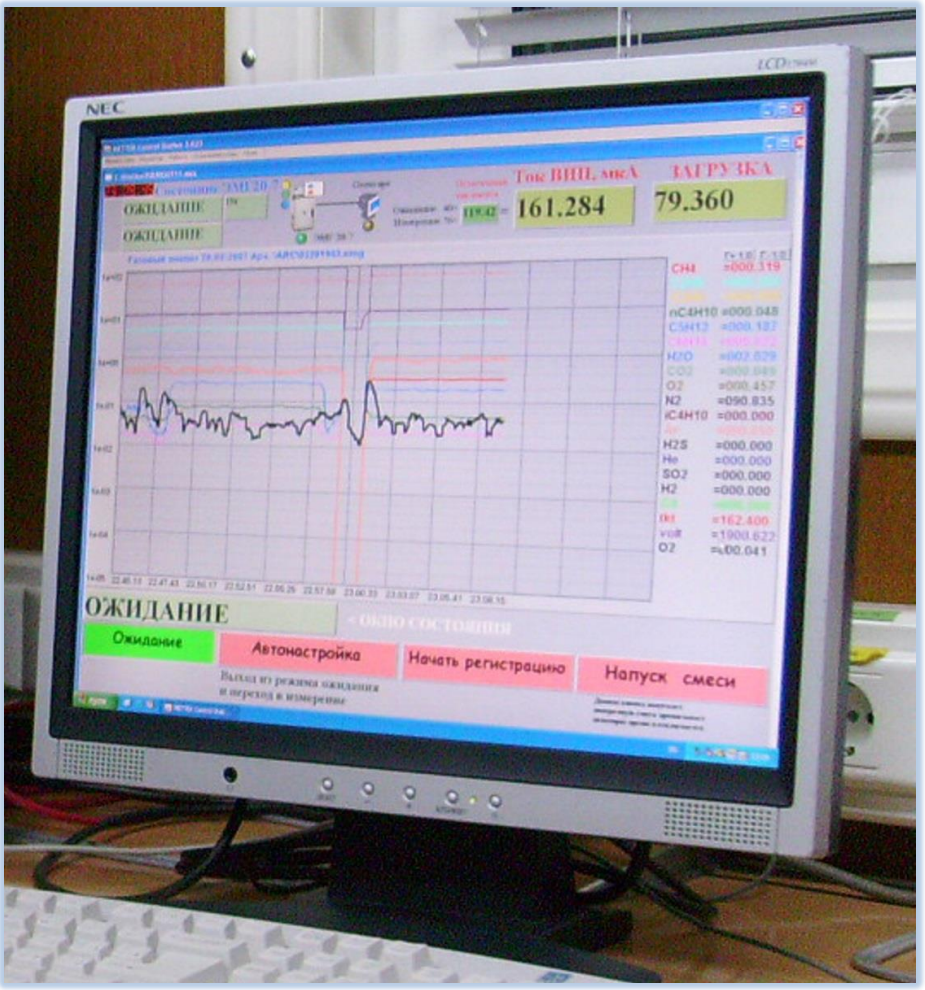
- Modular configuration
- Easy to mount/dismount
- Transportability
- Stability and reliability in field without CRM
- Convenient service and control
- High automatization with necessary locking
- Maintenance period 8-15 months
- Long period of exploitation

GAOS MS-20-7
Control software

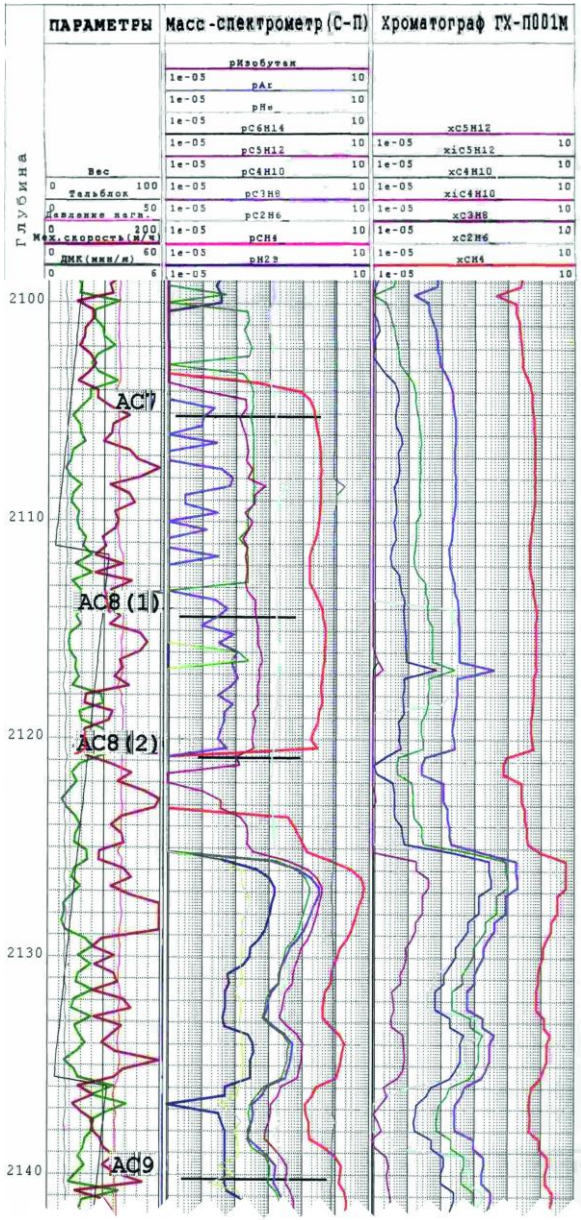
Parameters of the system

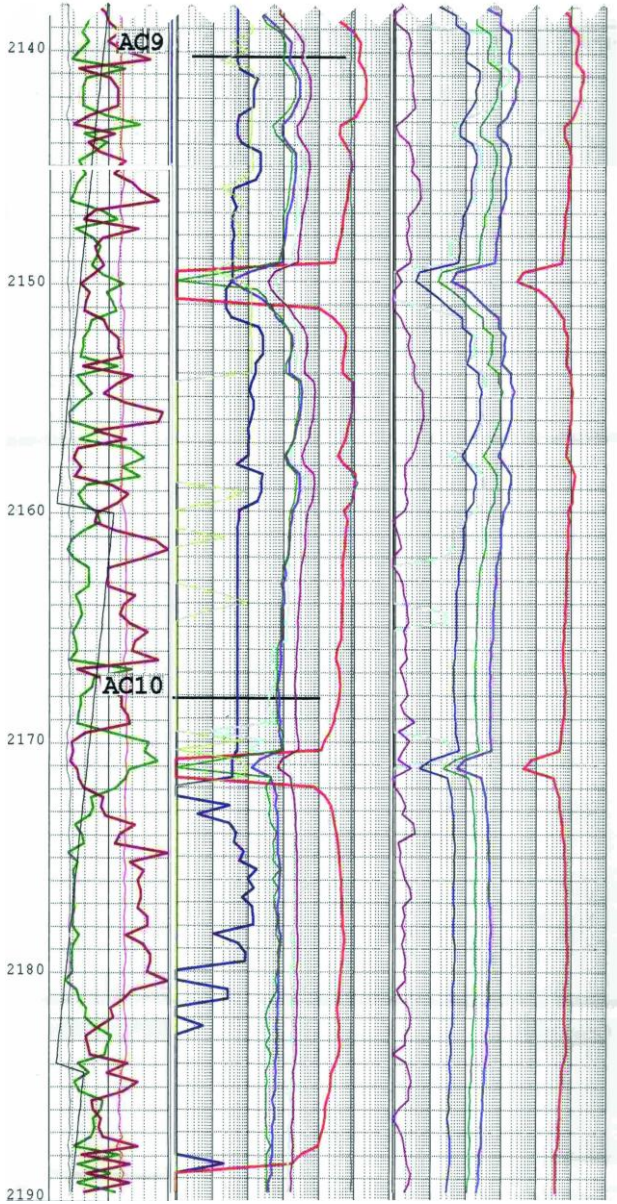
Measurements results

Control buttons



GAOS MS-20-7 Results





GAOS MS-20-7
Analytical task

Components	Concentration range, % vol.	
CH_4	$5,0 * 10^{-4}$	10,0
C_2H_6	$5,0 * 10^{-4}$	1,0
C_3H_8	$5,0 * 10^{-4}$	1,0
C_4H_{10}	$5,0 * 10^{-4}$	1,0
C_5H_{12}	$2,0 * 10^{-4}$	0,1
C_6H_{14}	$2,0 * 10^{-4}$	0,1
N_2	0,1	80,0
Ar	$1,0 * 10^{-2}$	2,0
He	$1,5 * 10^{-3}$	1,0
O_2	0,1	25,0
CO_2	0,1	1,0
SO_2	0,1	1,0
H_2S	$1,0*10^{-2}$	2,0

GAOS MS-20-7
Results

Components	Concentration, % vol.		Difference, % vol.	SD, % vol.
	CRM	Measurement		
CH_4	10,31 ± 0,01	10,297	0,013	0,042
C_2H_6	1,99 ± 0,09	2,075	0,085	0,004
C_3H_8	0,99 ± 0,03	1,024	0,034	0,0012
C_4H_{10}	0,533 ± 0,050	0,583	0,050	0,0002
i- C_4H_{10}	0,054 ± 0,006	0,048	0,006	0,0005
C_5H_{12}	0,0098 ± 0,0006	0,00989	0,00009	0,00004
C_6H_{14}	0,000117 ± 0,00007	0,00118	0,00001	0,00001

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Thank you!