

Distr.
RESTRICTED

ENERGY/WP.3/GE.1/R.6/Add.2
14 April 1994

ENGLISH
Original: RUSSIAN

COMMITTEE ON ENERGY

Working Party on Gas

Meeting of Experts on Natural Gas Resources
Seventeenth session, 16-17 June 1994
Item 5 of the provisional agenda

PROBLEMS ARISING IN THE EXPLORATION OF NATURAL GAS DEPOSITS LOCATED
IN ABNORMALLY HIGH PRESSURE AND TEMPERATURE CONDITIONS AND EXTREMELY
DEEP GEOLOGICAL FORMATIONS

(Replies to the questionnaire, transmitted by the
Government of Poland)*

1. Preliminary cartographical data on geological formations answering to this description are based initially on an interpretation of seismic profiles, using known geological cross sections from bores under exploration in neighbouring areas (where such bores exist). The drilling process provides data on the geophysics of the bore core samples from the different geological series and samples of drilling mud, petrographic and faunal analyses etc., making it possible to determine the age and type of rock being drilled, often to the nearest metre.

In an area where there is a sufficient number of bores, it is possible to determine lithological and facies parameters by correlating geophysical measurements without extracting any core samples during the drilling of new bores.

* In accordance with the decision of the Meeting of Experts at its sixteenth session, in June 1994 (ENERGY/WP.3/GE.1/6, para. 8 (a)).

2. Abnormally high formation pressures are usually related to individual geological formations and the tectonics of the deposits. High pressures are almost non-existent in the Carpathian foothills, where deposits lie almost flat; but in the Carpathians themselves, where the geological structures have undergone severe disruption, abnormally high pressures are omnipresent. Certain deposits, such as the Spassk deposits, reveal particularly high pressures, sometimes 100% higher than the hydrostatic pressure. The same is true for temperatures. There are cases of pressure and temperature abnormalities which can be represented graphically provided there is a sufficient quantity of drilling data.

During the drilling process, reference measurements are taken of temperatures and pressures and estimates are made of proximity to the zone of abnormality ("Geoservice").

Forecasts of abnormally high temperatures are obtained during the drilling process using the following methods:

Thermal profiling of the drilling fluid emerging from the well;

Profiling of stratum density;

Profiling of the d_c exponent.

Polish industry does not have the means of forecasting abnormally high formation pressures and pore-water pressures using seismic methods and geophysical exploration.

3. Depending on thermodynamic conditions, oil or gas influxes can be expected. In the Carpathian foothill region, in the Miocene deposits, natural gas can be found, while at the base of the Miocene layer (in the Carpathians) there are oil and gas fields. The presence of hydrogen sulphide is also a good indicator when combined with anhydrites or dolomites. These rocks are usually associated with H_2S .

4. Design features of deep and extremely deep wells when drilling under unusual temperature and pressure conditions

General methods:

(a) Surface casing and intermediate casing continued to maximum depth;

(b) A reserve supply is kept for an additional production string.

Example: design of the Kuzmin 1 well

Well depth - 7,541 metres

18 5/8" - 824 metres

13 3/8" - 2,660 metres

9 5/8" - 5,354 metres

6 5/8" - 5,104-6,582 metres - shank

Open hole - 6,582-7,541 metres

Temperature at well bottom - 176°C

A mixture containing chromium salt (chromal) was previously used to treat drilling mud under high temperature conditions; however, owing to its toxicity, it is no longer used.

The cements used in the casing are resistant to high temperatures, or additives to slow down the setting process (tartaric acid) are used together with plasticizers.

5. By means of surveys using Geoservice equipment it is possible to detect abnormally high pressures in the zone above a field before drilling in. A careful analysis of the drilling mud and, in particular, frequent temperature measurements may reveal thermal abnormalities. Two methods are employed for forecasting pore-pressure:

Measurement of stratum density in the Geoservice laboratory;

Determination of the standard energy index for the drilling rate.

6. Drilling into formations at abnormally high pressures requires particular care during the test period. In order to avert shows of gas or oil, care must be taken to ensure that only drilling muds of the right density and characteristics are used during perforation. The density of drilling mud used during perforation is the same as for the drilling of the test interval. New horizons are being opened up by a perforation method employed by such Western companies as VAN-SYSTEMS.

7. Testing procedure for wells in formations at abnormally high pressures

Tests are carried out using formation testers in a cased well; should a commercial inflow be encountered, imported production heads are used.

8. Geophysics offers a relatively broad range of measurements on the basis of which rock porosity and permeability can be calculated and parameters such as friability, bore-narrowing, grooves, water release and borehole wander can be determined. This applies both to wells at abnormal pressures and temperatures and to normal conditions.

9. Studies on the electrical properties of rocks at high temperatures and pressures

volume density

✓

Density

✓

structural density

Porosity

Capillary pressure curve

Capillary diameter and specific surface
