P583 MEASUREMENTS OF SOIL GAS MIGRATION AROUND GAS WELLS

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Each petroleum accumulation in the subsurface is the source of persistent efflux of hydrocarbons into surroundings due to existing concentration and pressure gradients. This refers mostly to low-molecular gas particles which migrate vertically up to the surface firstly as a result of diffusion then, also by effusion until they are dispersed into the atmosphere. During their migration the hydrocarbons influence the rocks and soils thus, changing their geochemical characteristics (*Tedesco, 1995; Sokolov, Grigoriev, 1962*). The precise record and combined analysis of surface hydrocarbon gas components allow to restore soundly justified whys and the wherefore of surface geochemical anomalies. The composition, characteristics and areal distribution of surface gas anomalies make it able to predict the occurence, character and phase composition of oil and/or gas accumulation in the subsurface as well as to identify some features of the cap-rock structure and its characteristics. The surface hydrocarbon gas distribution is not only indicative when searching for petroleum accumulations but also very useful to locate the zones of potential gas leakage from wells.

The geochemical studies aimed the evaluation of technical conditions of the four wells: L-1, L-7, ST-1k and ST-2k from the point of view of possible hydrocarbon emission and resulting pollution of the environment.

The "free gas" method was applied as it allows to evaluate the "current" migration dynamics of gaseous components from the accumulations to the Earth surface and to the atmosphere (*Brooks & Welte, 1987; Saunders et al., 1993*). The compositional and pressure gradients between accumulations and the Earth surface trigger the migration as early as at diffusion stage. Hence, studies on distribution of petroleum-derived gaseous components in the subsurface zone enable the early determination of their escape from the accumulation, i.e. lead to the identification of potential well leakages. The application of quick and relatively unexpensive methods of surface geochemical surveying allows disclosure of leakages in wells with sensitivity far exceeding the precision of manometers mounted to the wellheads.

Studies were carried on within the 50-meters-radius circle around the wellsites. For the L-1 well measuring points were arranged in N-S/E-W-oriented square grid (20x20 meters) with the wellsite as central point. Additionally, 6 points were located around the wellsite – four about 5 meters from the site to the north, south, east and west, and 2 other about 2 meters from the wellsite, in accessible places.

In the vicinity of clustered L-7, ST-1k and ST-2k wells the identical grid was arranged with the central point at the ST-2k wellsite. Additional points were located between the wells.

In both areas samples were taken from the depth interval 1.2 – 1.0 meter. According to the results of experimental studies (*Dzieniewicz et al., 1978, Górecki et al., 1995*) and data from the literature, such sampling depth is an optimum as it represents the subsurface zone but eliminates most of the influence of external factors.

Samples were collected with a driving rod, syringe and vessel. The sampling procedure (*Dzieniewicz & Sechman, 1997a, 1997b*) ensures "sterile" conditions and eliminates the contamination from atmospheric air.

Collected samples were analyzed mainly for the presence of methane and succeeding light homologues (ethane, propane, i-butane, n-butane, i-pentane, n-pentane) as well as gaseous alkenes (ethylene, propylene, 1-butene).

The higher gaseous hydrocarbons were detected in 55% of analyzed samples from the In the area of L-1 well and in 83% of those from the vicinity of remaining wells. In the latter area both the sum of alkanes and alkenes also reach maximum values: 1.7% (average about 620 ppm) and about 104 ppm (average 3.18 ppm), respectively. Alkenes were detected in about 40% of analyzed samples.

In the vicinity of the L-1 well the total, maximum concentrations are one order of magnitude lower for heavier alkanes (about 0.3%, average about 68 ppm) and two orders of magnitude lower for sum of alkenes (1.4 ppm, average 0.07 ppm). Their presence was indicated in only 14% of analyzed samples.

Such concentrations not only pollute the environment but cause serious fire and explosion hazards. It must be emphasized that methane forms highly explosive mixture with the air at concentrations between 5.3 and 15.0% (*Kozłowski 1982*).

Comparison of studied areas allows concluding that in the vicinity of the L-1 well the hazards are of local character whereas in the vicinity of the three other wells the range of pollution is apparently extended.

In the area of the L-1 well significant methane anomalies were observed in the close neighbourhood of the well and, locally, about 14 meters northeast of the wellhead. The measured values ranged from 27 ppm to about 11.2%. These anomalies were confirmed by the increased sum of alkanes.

In the area of the L-7, ST-1k and ST-2k maximum values were found in the central part of the area (Fig.1). On its western side the belt of hazardous values (i.e. exceeding the lower explosive limit) occur. Similar hazardous concentrations were indicated in the eastern side where they form an irregular, SE-NW-trending zone. Extreme methane concentration - almost 39% - was measured about 30 meters north of the L-7 well. Distribution of sum of alkanes corresponds to that of methane anomalies.

Evaluation of measured concentrations, the presence of specific homologues (both saturated and unsaturated) and their mutual relationships lead to the genetic conclusions (*Sokolov & Grigorev, 1962; Jones & Drozd, 1983; Starobiniec, 1986; Tedesco, 1995; Dzieniewicz & Sechman 1996*).

In conclusion, it must be emphasized that results of geochemical surveying demonstrated rather poor technical conditions of the studied wellsites, particularly the L-7, ST-1k and ST-2k wells.

In both studied areas the well leakages are potentially hazardous including fire and explosion dangers.

REFERENCES

Brooks J.M., Welte D., 1987 - [Advances in petroleum geochemistry]. Vol. 2, Academic Press, London.

Dzieniewicz M., Kuśmierek J., Rusta T.M., 1978 – [Optimization of gas surveying technique with the experimental studies]. Techn. Posz. Geol. 1, Warszawa. (in Polish).

Dzieniewicz M., Sechman H., 1996 – [Application of surface geochemical surveying in petroleum exploration]. Com. Scien. Res., Project No. 9.9238.92.03. Unpubl. manuscript, Archive. Dept. Fossil Fuels, Univ. Mining & Metallurgy, Kraków. (in Polish).

Dzieniewicz M., Sechman H., 1997 – [Method and apparatus for manual gas sampling in subsurface layers]. Patent No. P-318479 valid since Feb. 12, 1997 (in Polish).

Dzieniewicz M., Sechman H., 1997 – [Die of a driving rod for soil studies]. Utility model No. W-106466 valid since April 29, 1997 (in Polish).

Górecki W., Strzetelski W., Dzieniewicz M., Sechman H. - [Surface geochemical survey of gas accumulations in Polish Lowlands]. Ext. Abstr. EAGE/EAPG 57-th Conference and Technical Exhibition - Glasgow, Scotland, 29 May - 02 June 1995.

Jones V.T., Drozd R.J., 1983 – [Prediction of Oil and Gas Potential by Near-surface Geochemistry]. AAPG Bull. 67, 6.

Kozlowski B., 1982 – [Mine gases]. PWN, Warszawa-Kraków. (in Polish).

Saunders D.F., Burson K.R., Brown J.J., Thompson C.K., 1993 - [Combined geological and surface geochemical methods discovered Agaritta and Brady Creek fields, Concho County, Texas], AAPG Bulletin, Vol. 77, No. 7.

Sokolov W., Grigorev G.G. – [Methods and results of gas geochemical surveying for petroleum exploration]. Nedra, Moskwa. (in Russian).

Starobinec I.S., 1986 – [Gas-geochemical indicators of hydrocarbon potential and prediction of composition of hydrocarbon accumulations]. Nedra, Moskwa. (in Russian).

Tedesco S.A., 1995 – Surface geochemistry in petroleum exploration. Chapman & Hall. New York.

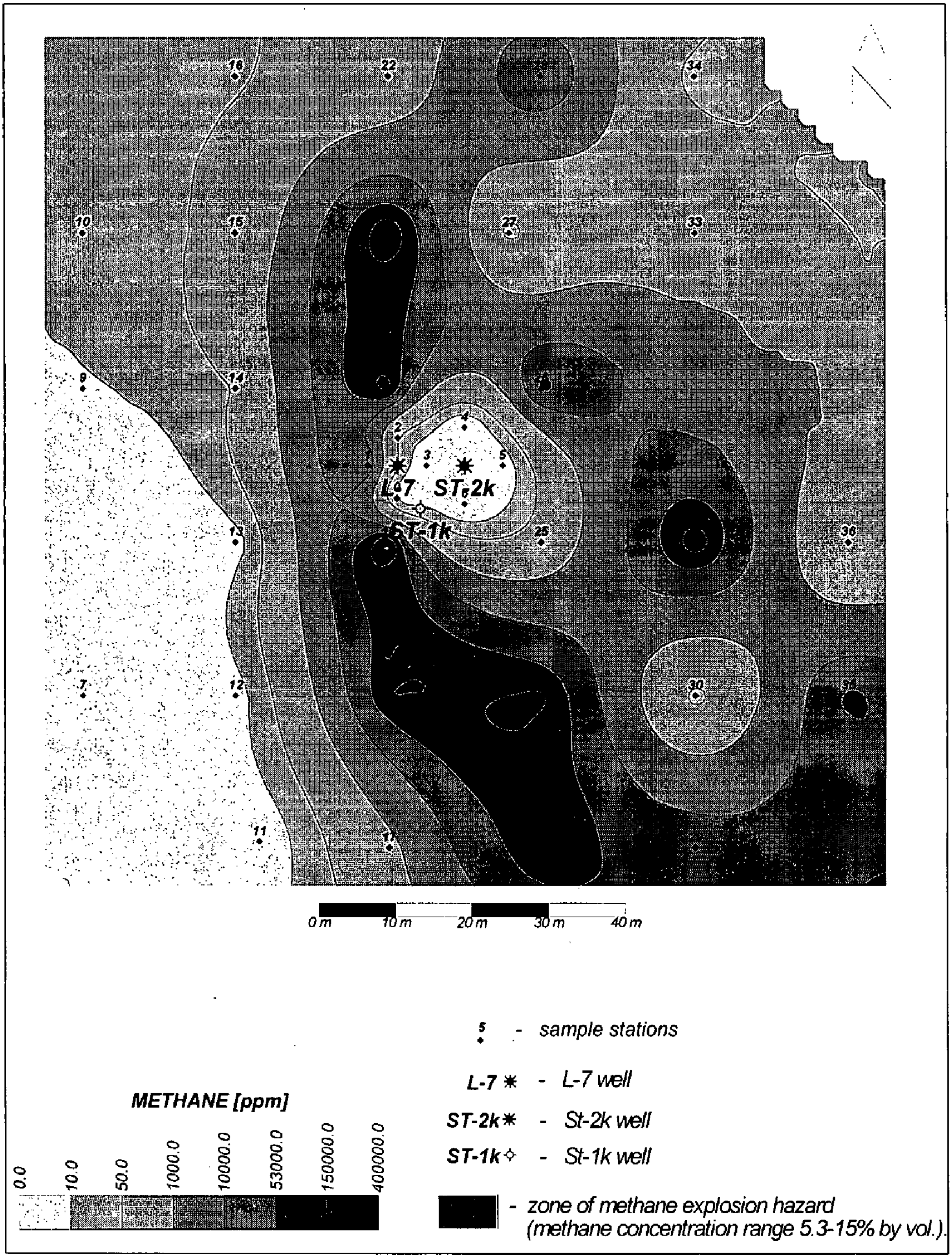

Fig. 1 Distribution of methane concentration in the vicinity of the L-7, St-1k, St-2k wells