

PILOT STUDIES FOR GROUNDWATER PROTECTION IN CZECHOSLOVAKIA

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ABSTRACT

Pilot studies have been carried out as a part of Hydrocarbon Pollution Prevention Project in the years 1977 to 1980.

Section of Mesozoic basin, with overall resources exceeding 6000 l pro sec. has been selected. Groundwater is bound to sandstones with shallow unconfined aquifer. Geology, hydrogeology, existing pollution and protection are described and measures for extensive protection are given.

Pilot study for mineral water protection has been executed in Konstantin Spa area, where gaseous mineral water occurs in fissured proterozoic slates. Geology and hydrogeology are described and protection measures are specified together with surveillance.

The hydrocarbon gauges, recommended for boreholes inspection are shown and described.

The hydrocarbon pollution of groundwater is one of serious pollutions, which occurs several times every year in Czechoslovakia. The most frequented cases are spills and leaks from stores. Thus, the systematic prevention in all areas where groundwater in drinking grade occurs is rather commanding.

The northern part of the Cretaceous basin in Bohemia has lithology favourable to store groundwater. The area of 1200 sq. km. harbours some 6000 l/s of excellent groundwater, which is bound to sandstone layer, thickness of which being 50 to 200 m. For pilot study, section of this basin, some 200 km² /Watershed of Libechovka River/ has been selected.

The Libechovka watershed forms peneplain-like landscape, elevation of which is 400 to 600 m. In opposite to this, Libechovka river is situated in cuts 50 to 100 m deep, with steep slopes and rock walls, with exposed layers of sandstone. The river has extremely low variati-

on of discharge, as a result of high storativity in sandstones.

Main aquifer is bound to sandstones of turonian age, medium grained rock with small amount of kaolinite and calcite, with low resistivity against cracking. Weathering into vertically shaped rocks with extensive dejection cones at its foot is common. The aquifer bound to sandstones is the main one in Libechovka watershed, and has resources over 260 l/s, certified by simultaneous pumptesting from 12 boreholes.

The lower aquifer is developed in cenomanian strata, fairly confined, and the water is mineralised and with positive hydrostatic level.

The watershed is divided by "Zaksin fault" into the couple of sub-structures, nearly independant, both of them having over 130 l/s .

The river course, being cut into sandstones, is underlined by layer of sand, thick 2 to 20 m. Peat layers - 2 to 4 layers, with overall thickness up to 15 m are interbedded into those sands, creating local good insulation of groundwater against the river, to such extent, that the static water level in boreholes rised 3 to 5 m above the ground level after the bedrock was taped.

The main "points of weakness" from the water-protection wiew are:

- The sandstone has low ability to retain the hydrocarbons / by sorption, filtration and/or mineralisation/
 - some sections where the river recharges into the groundwater already exists and they are proved by hydrometry.
 - groundwater is frequently seeping into the river /proved by thermometry/
 - danger of "inversion" from groundwater seeping to groundwater recharging due to the water pumping for waterworks in near future
- The protection against hydrocarbon pollution shoud comprise:
- regular common protection in accordance with ČSN /Czecholovak State Standard/, Water Bills and related regulations
 - extended common protection: all sites expected to be used in future are to be protected to the same grade as existing wells and boreholes, as well as all areas between depression cones, which should be considered as integral parts of protected area
 - special anti-hydrocarbon protection should include:
 - exhausting application of the Bill No 6/77 /"Hydrocarbon storing, transport and handling"/
 - continuous monitoring of all hydrocarbon tanks with capacity over 200 l
 - removing hydrocarbon stores situated within Libechovka watershed
 - sleeved tanks for domnestic use, size of those limited to 200 l

- encouraging the use of gas instead of liquid hydrogen for domestic use
- permanent monitoring of surface water for hydrocarbon slicks
- insection boreholes situated close to all petrol stations /both commercial and industrial/ used for groundwater sampling
- traffic restriction for tankers on exposed areas,no-stop zones close to waterworks and recharge sections,no heavy vehicles on weekends etc.
- prevention of hydrocarbon pollution from sewage
- groundwater to be exploited in manner preventing recharge in unsuitable areas
- Inspection and Maintenance Plan for Libechovka watershed,including periodical checks of all devices,plan of water sampling and extent of supervision executed by Regional Water Authority
- conditions and limits for establishing and removing of the "Hydrocarbon Pollution Emergency"
- similar plan for "Hydrocarbon Pollution"

The relevance period for the measures stated above has been limited to 10 years, due to the expected development in groundwater protection policy.

Mineral Water Protection Study has been executed around Konstantine Spa, located between Karlovy Vary /Karlsbad/ and Plzen /Pilsen/.The particular type of hydrogeological structure here is gaseous water bound to fissures and other tectonic elements, and the protection system suggested here can be utilised in 40 to 50 similar structures in Czechoslovakia.

The landscape surrounding Konstantine Spa is rather hilly,fairly forested, 600 to 900 m above sea level. The proterozoic slates,metamorphied into phyllites form the bedrock in the intire area,except some basalt dykes,forming insulated steep hills.Clayly soils are developed on both proterozoic and effusives.

Groundwater is bound to fissures in Proterozoicum,while the carbon dioxide is supplied by several faults,being considered the last mark of the neogene volcanism.The zone of mixing is known to be in the depth of 100 to 150 m.The carbon dioxide content in water is some 3000 mg/l, but dissolved ions occur /except of iron/ in minor amounts. The mineral water is used by some 3000 indoor patients every year, exclusively for heart and arthritic diseases curing.

High level of protection is already established here by 3 staged protecting "circles" imposed there by The Mineral Waters and Spa

Inspectorate /dept. of the Ministry of Health/. Only special "anti-hydrocarbon Items" have been therefore suggested, consisting of:

- extensive use of the Bill No 6/77 /as in Libechovka watershed/
- inventory and technical check of all hydrocarbon tanks, even all tanks for domestic use, removing obsolete and unsafe tanks immediately
- periodical checks of hydrocarbon content in selected boreholes wells and streams.
- restriction of tankers in the entire protected area, and speed limit for all and restriction for heavy vehicles in Konstantine Spa and near environment.

The hydrocarbon analyses / ground and surface water/ has been requested in both areas to be carried out by infraphotometer, using freon as the solvent. For undissolved hydrocarbon / hydrocarbon layer floating on groundwater/ oil dippers has been developed as field devices. Conductometric bridge for water level and optoelectric sensors for air-liquid border are employed. Both types /field type in leather case with neckstrap/ and supervising type /fig.2./ has been put in operation some 18 months ago. For thin layers /0,5 to 5 mm/ electronic minisampler /fig.3./ has been used. All of them has been found helpfull.

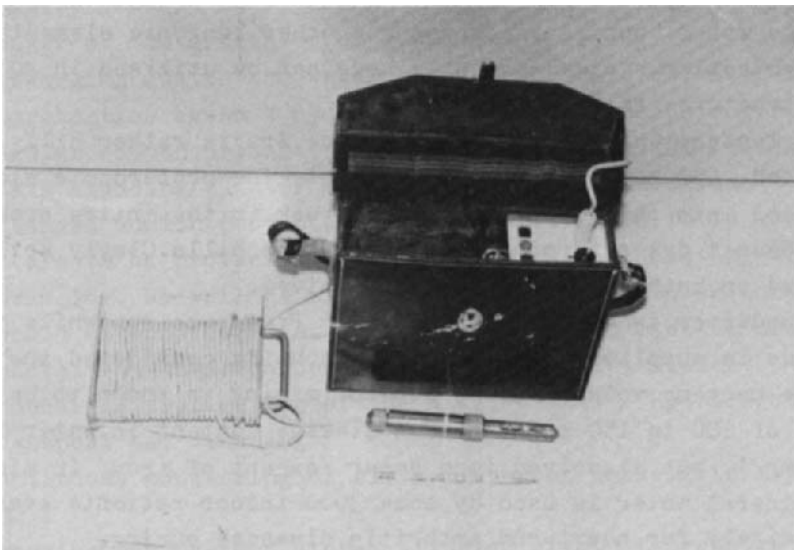


fig.1.

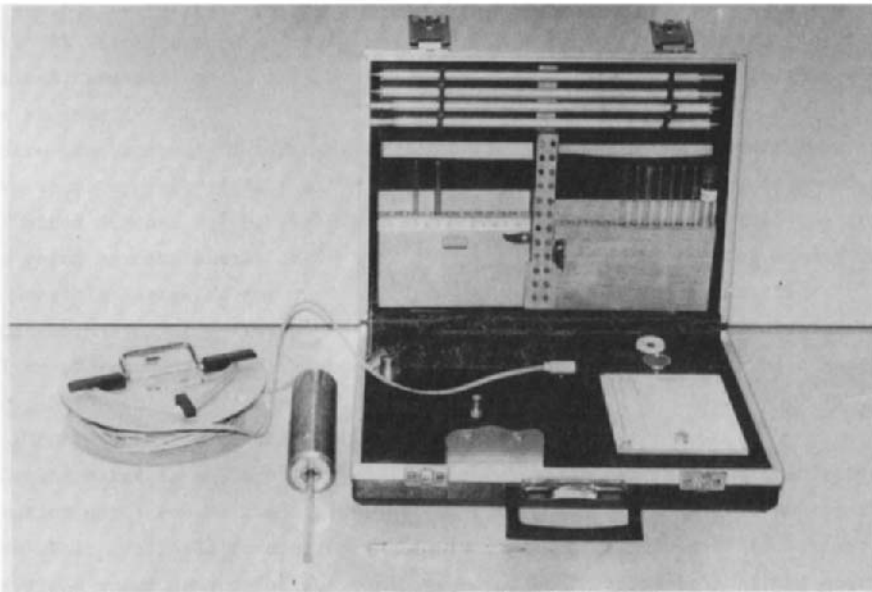
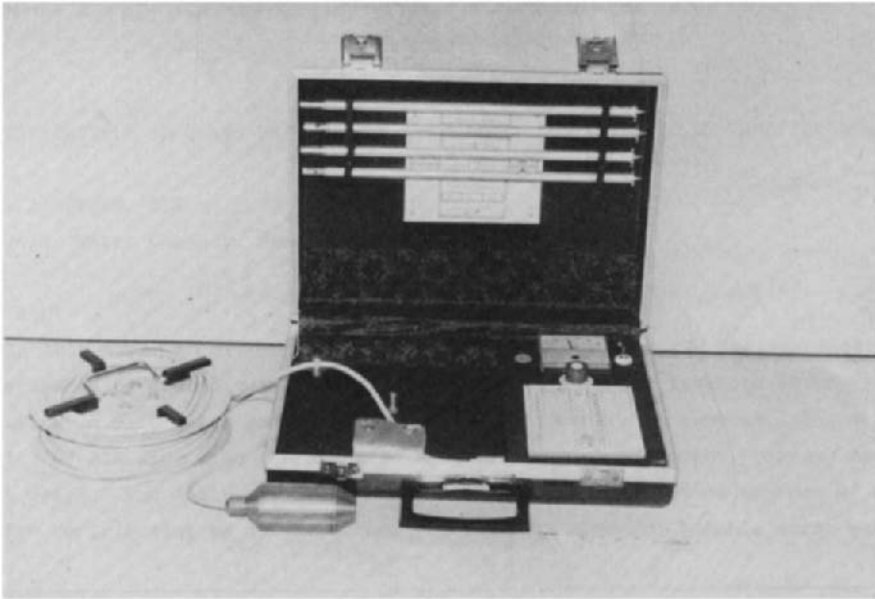


fig.3.