Polish Geological Institute Special Papers, 18 (2005): 15–21
Proceedings of the Conference "Hydrogeological transboundary problems. West and East European Bridge"

BRIEF CHARACTERISTIC OF THE HYDROGEOLOGICAL SITUATION ALONG THE POLISH-SLOVAK BOUNDARY BELT

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Abstract. The paper gives a brief information on up-to-date status of knowledge on groundwater in Slovak Republic territory. The borderline between Slovak Republic and Poland is about 541 km long following mostly mountain range combs. Hydrogeological conditions are set up by geological situation. Area adjacent to the borderline is built mainly of flysch sediments, Mesozoic sediments and crystalline rocks in different tectonic positions.

Groundwater in flysch sediments has relatively shallow circulation; groundwater and orographic divides are identical. Aquifers in these sediments have low importance for transboundary flow. Mesozoic sediments crop out in the form of tectonic units (nappes) in the area of Tatra Mts.or in the form of lenses in the Klippen belt. Hydrogeological structures evolved in Mesozoic sediments can have some transboundary communication of groundwater.

From mid nineteen seventies, groundwater in Slovak Republic is classified and annually balanced for 141 hydrogeological regions. In accordance with the Water Framework Directive (2000/60/EC), Kullman *et al*. (2004) gave a proposal of the groundwater bodies delineation based on existing units, taking into account predominant permeability types. Vertically three "layers" of groundwater bodies were delineated: layer of Quaternary sediments, pre-Quaternary groundwater bodies, layer of geothermal waters.

Key words: transboundary aquifer, hydrogeological structure, hydrogeological region.

Abstrakt. Artykuł przedstawia aktualny stan wiedzy o wodach podziemnych na obszarze Republiki Słowacji. Granica słowacko-polska ma długość wynoszącą około 541 km i przebiega głównie szczytami grzbietów górskich. Warunki hydrogeologiczne zależą przede wszystkim od budowy geologicznej. Obszar przylegający do linii granicznej jest zbudowany głównie z osadów fliszowych i mezozoicznych oraz skał krystalicznych, występujących w różnych strukturach tektonicznych.

Wody podziemne w osadach fliszowych występują płytko. Ich zasięg pokrywa się z jednostkami morfologicznymi. Zbiorniki wód podziemnych, występujące w tych osadach, w małym stopniu przekraczają granice państwowe. Utwory mezozoiczne występują w Tatrach w formie jednostek tektonicznych (płaszczowin), a w pasie skałkowym — w formie soczew. Struktury hydrogeologiczne rozwinięte w utworach mezozoicznych mogą mieć transgraniczne połączenia swoich wód podziemnych.

Od połowy lat 70. wody podziemne Republiki Słowackiej są klasyfikowane oraz corocznie bilansowane w każdym ze 141 regionów hydrogeologicznych. Kullman *et al*. (2004) zaproponowali, zgodnie z Ramową Dyrektywą Wodną (2000/60/EC), podział jednolitych części wód podziemnych według dominujących rodzajów przepuszczalności. W pionowym układzie wydzielono trzy „warstwy" jednolitych części wód podziemnych: „warstwę" jednolitych części wód podziemnych w utworach czwartorzędowych, podziemne ciała przedczwartorzędowe oraz „warstwę" wód geotermalnych.

Słowa kluczowe: transgraniczny zbiornik wód podziemnych, struktura hydrogeologiczna, region hydrogeologiczny.

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INTRODUCTION

The Slovak Republic is situated in the Central Europe and borders with five states: Hungary, Poland, Czech Republic, Austria and Ukraine, with the total borders length of 1,662.7 km. The Slovak-Polish border accounts for 541,079 km (Fig. 1). From geological point of view, Slovakia is a part of the Western Carpathians (WCpt) territory, and the Slovak-Polish border is situated completely within it. WCpt are characterised by very heterogeneous geological environment with typical fold-nappe structure. Border follows mainly combs of partial mountain ranges of Carpathian arc and is regarded as an example of the natural border. The border is generally identical with orographic divide, and the groundwater divide is more--less identical with the geographic one. Hydrogeological structures in border zone are bound to a few types of geological environment: crystalline rocks, Mesozoic carbonates, Mesozoic and Palaeogenic flysch formations and Quaternary sediments.

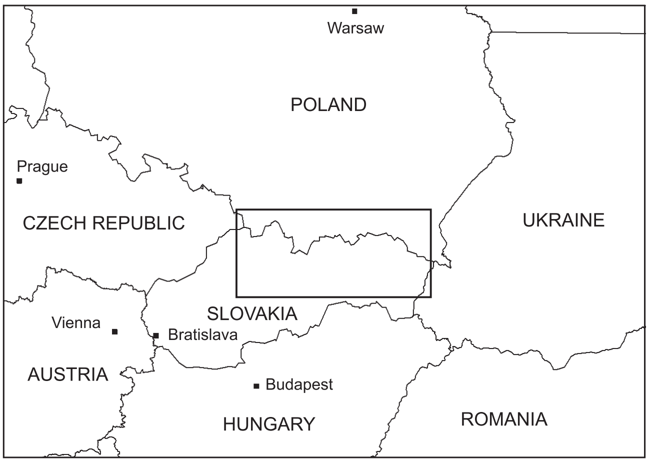

Fig. 1. Slovak-Polish transboundary area

SOURCES OF GEOLOGICAL AND HYDROGEOLOGICAL INFORMATION

Geological maps create an important basis for compiling the hydrogeological maps. The whole area of Slovakia is covered by geological maps at a scale of 1:50,000 (now being digitalised). Current state of knowledge on geological setting of WCpt has been summarised in "Geological map of Western Carpathians and adjacent areas at a scale of 1:500,000", published together with the correlation tables of lithostratigraphic units and a legend to geological map (in Slovak and English, Lexa *et al*., 2000).

A lot of geological and hydrogeological information on the Slovak Republic territory is stored mostly in the main archive of the Geological Survey of Slovakia in Bratislava (http://www.gssr.sk/geofond or http://geolisis.gssr.sk/geofond)), and the archive of the Slovak Hydrometeorological Institute (http://www.shmu.sk). The basic knowledge on hydrogeological situation is summarised in hydrogeological and hydrogeochemical maps at a scale of 1:200,000 which present hydraulic properties and chemical composition of groundwater in the first subsurface aquifer. These maps (12 sheets in total) were completed in the mid-1970s covering the whole area of Slovakia. More detailed information on hydrogeological situation is given on maps at a scale of 1:50,000 (not covering the whole area of Slovakia), and in other local prospecting works. The maps were printed within the former Czechoslovak national geodetic projection JTSK.

After WWII, up to 1974, groundwater in Slovakia was classified and balanced within main watershed regions. However, groundwatersheds are inconsistent with orographic watershed. After the completion of the hydrogeological maps (scale 1:200,000), 142 (in 1992 updated to 141) hydrogeological regions were delineated for complex balancing. The term "hydrogeological region" — in Slovak "hydrogeologický rajón" — is sometimes translated as "hydrogeological unit or region". Those hydrogeological regions were selected with regards to the presence of main stratigraphical units (crystalline "G", Mesozoic "M", Palaeogene "P", Neogene "N", Quaternary "Q") and possibility of closed groundwater cycle (infiltration–accumulation–output) in the hydrogeological structures. Annually, a report of each region is completed for each hydrogeological region within the framework of the State Water Balance report, prepared by Slovak Hydrometeorological Institute. Due to the need of better link between balancing profiles of surface waters, hydrogeological regions were subdivided into sub-regions according to their position in the areas of surface watersheds. Partial regions (parts of regions) depict the partial hydrogeological structures based on the identical geological conditions.

Water Framework Directive (2000/60/EC) is a directive that forms the basic legislation for the protection of the European aquatic environment. Delineation of the hydrogeological regions in the mid-1970s followed the natural settings due to the best knowledge of those times, therefore, the boundaries of the groundwater bodies, following the implementation strategy for the Water Framework Directive (2000/60/EC), can be based on the existing units, and generated by combining them on the base of the dominating permeability types (Kullman *et al*., 2004).

At present, three "layers" of groundwater bodies were delineated on the Slovak territory, following the primary division in 141 hydrogeological regions, subregions and partial regions for the first two layers. At first, a layer of Quaternary sediments was generated, and then the underlying layer of pre-Quaternary groundwater bodies (including not significant Quaternary water bodies). For pre-Quaternary groundwater bodies, 5 categories were distinguished, characterised by analogical groundwater circulation types:

— dominantly karst-fissured groundwater bodies of the Inner Carpathian zone;
— intergranular groundwater bodies of basins and intramontaneous depressions;
— fissured and karst-fissured groundwater bodies of the Inner Carpathian zone;
— fissured and intergranular groundwater bodies of neovolcanic rocks;
— fissured groundwater bodies of flysch belt of the Outer Carpathians flysh sediments and subtatra group; pre-Quaternary layer was divided in the next step according to the surface watersheds.

Independent layer of geothermal waters was identified as shown beneath. 26 perspective geothermal structures in the Mesozoic carbonates (Triassic) of the Inner Carpathians and fewer in the Neogene sedimentary or neovolcanic structures were distinguished in the past (Franko *et al.*, 1995; Fendek *et al*., 2002).

These days a new proposal of water bodies delineation is being elaborated. Present regulations will require more effort to cope with already delineated surface water bodies as well as to cope with the future transboundary groundwater bodies problem.

GEOLOGY AND HYDROGEOLOGY ALONG THE SLOVAK-POLISH BORDER

Hydrogeological conditions are determined by the geological environment. The basic lithological units with predominant permeability types along the Slovak-Polish border are as follows (Fig. 2):
— crystalline rocks with fissure permeability — basement of Tatric unit, present in the Tatra Mts. area;
— Mesozoic limestones and dolomites with fissure-karst permeability, belonging to Tatric, Veporic (fatric) or Hronic units of the Inner Carpathians and to Klippen belt;
— flysch sediments, conglomerates and claystones with fissure permeability;
— Quaternary sediments (glacigenic, glacifluvial and fluvial sediments) with intergranular permeability.

The WCts are classified according to the age of the Alpine nappe structure development as the Outer WCts (with Neo-

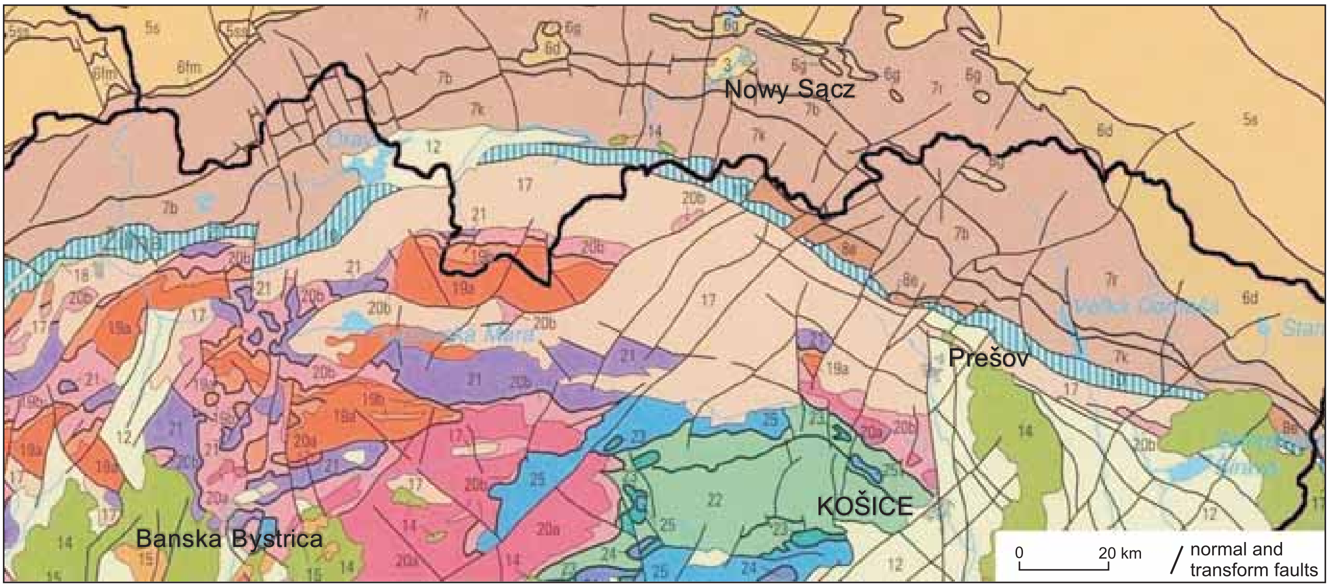

Fig. 2. Structural scheme of Western Carpathians and adjacent areas, section from Geological map of Western Carpathians and adjacent areas (Lexa *et al*., 2000)

5 — Krosno nappe-group of the flysch belt and equivalents in the Alps: sk – Skole, ss — Subsilesian, s – Silesian, a – Ždánice, w – Waschberg, mz – marginal zone; **6** — Foremagura units of the Carpathian flysch belt: d – Dukla, g – Grybów, fm – Foremagura *s.s.*, p – Porkulec; **7** — external Magura nappes of the flysch belt and equivalents in the Alps: r – Rača, b – Bystrica, k – Krynica/Dravská Magura, g – Greifenstein; **8** — internal Magura nappes of the flysch belt and equivalents in the Alps: bk – Biele Karpaty, lb – Laab, e – equivalents; **9** — Kahlenberg nappe, St. Veit, Ybbsitz and Sulz klippen zones; **10** — Pieniny klippen belt; **11** — Penninicum *s.s.* (southern Pennicum); **12** — Neogene to Quaternary sedimentary rocks of interarc and backarc basins; **13** — alkali basalts (Pannonian–Quaternary); **14** — andesitic volcanic rocks (Neogene); **15** — rhyolitic volcanic rocks (Neogene); **16** — Eocene to Early Miocene sedimentary rocks of the Buda Basin; **17** — sediments of the Inner Carpathian Palaeogene; **18** — sediments of the Gosau, Myjava and Hričov groups (Late Cretaceous to Eocene); **19a**, **b** — Tatricum, Unterostalpin in the Alps (lower Wechsel–upper Semmering series): a – crystalline basement, b – sedimentary cover; **20a**, **b** — Veporicum, Zemplinicum, Mittelostalpin in the Alps: a – crystalline basement, b – sedimentary cover and Krížna nappe; **21** — Hronicum, Tirolicum of the Oberostalpin in the Alps (Ötscher nappe group); **22** — Gemericum, Grauwacken zone of the Oberostalpin in the Alps (Noric and Veitsch nappes); **23** — Meliaticum; **24** — Turnaicum; **25** — Silicicum, Juvavicum of the Oberstalpin (Hohewand and Schneeberg nappe); **26** — Dinaricum (Bükkicum and Mesozoic rocks of the Hungarian Central Range)

-Alpine nappes) and the Inner WCts (with Palaeo-Alpine – pre-Palaeogene nappe structure). The Klippen belt marks the boundary between these two areas.

Outer Carpathians represent an external part of WCts and are composed of three groups of nappes. On Polish-Slovak border these nappes can be found in two areas: in the west — from Czech-Slovak border to Orava dam, and in the east — roughly from Piwniczna–St. Lubovňa area, to Ukraine-Slovak border. Outer Carpathians are formed predominantly by flysh sediments with fissure permeability. Groundwater has a shallow circulation down to the depth of 20–40 m (Zakovič *et al.*, 1990), with groundwater discharge in small springs, mainly in depressions and at contacts of psamitic and pelitic members or tectonic zones. The orographic watersheds correspond with groundwater divides. As the borderline follows mostly mountain ridges, there is a small chance of transboundary groundwater communication.

Klippen belt in the form of a narrow northward bulging belt is one of the most complicated structures in the Western Carpathians. Typical are Jurassic–Lower Cretaceous limestones which intersect the Cretaceous and Palaeogene marlstones and flyshes. Klippen belt on the Polish-Slovak border builds hills of Oravská vrchovina and Oravská Magura near Trstená, and in the east builds the Pieniny Mts. Limestones have fissured permeability. Hydrogeological structures are small with discharge in springs mostly on contacts with impermeable marlstones.

Inner Carpathians are vertically stratified into a nappe complex, overlain by post-nappe Upper Cretaceous to Neogene sedimentary formations. They can be found in the central part of Polish-Slovak border, in the Tatra mountains area. The following tectonic units can be found in area adjacent to the borderline:

1. Tatricum – represented by crystalline rocks (*core*), overlaid by Late Palaeozoic and Mesozoic cover (lower Triassic to upper Cretaceous), lithologically composed of dolomites, limestones, quarcites, shales, evaporites, cherts, marlstones (parautochton on crystalline, *cover*).

2. Veporicum unit (Krížna nappe) — overlies the Tatricum unit with similar lithological composition, as well as Hronicum unit (Choč nappe) in the superposition.

Crystalline rocks are developed in the Tatra Mts. and belong to the basement of the Tatric unit. These rocks are represented by granites, granodiorites, gneisses and migmatites. They are characterised by fissure permeability mainly and by generally mean transmissivity. The depth of the weathered top zone, important for transport and accumulation of groundwater, varies between 15 and 50 m (Melioris, 1971 *in*: Zakovič *et al*., 1990). However, mylonite zones may play important hydraulic role, too.

Mesozoic rocks, Triassic dolomites and limestones, create an important water-bearing environment in the Western Carpathians. Springs are evolved in tectonic zones or impermeable layers. Permeability is mainly fissured and karst fissured. Along the Polish-Slovak border, they (?dolomites, ?springs or something else?) can be found in the Tatra Mts., from west to east in the Western Tatra Mts. (Západné Tatry along with Červené vrchy Mts.), and in the northern part of the High Tatra Mts. (Vysoké Tatry) and Belianske Tatry Mts. Mesozoic rocks have nappe structure and are folded.

The Inner Carpathian Palaeogene sediments fill a belt along the inner margin of the Klippen belt. Sediments are composed of basal conglomerates, claystones, and flysch formation of total thickness up to 1,000 m. They form a belt starting from the west in the Skorušinské vrchy Mts., continuing to Poland (Zakopane–Biały Dunajec), and crossing back to Slovakia in the Spišská Magura Mts. Fissured permeability can be found in these rock types.

Glacigenic and glacifluvial Quaternary sediments represent an important environment for groundwater accumulation. These sediments with intergranular permeability are often draining groundwater from crystalline rocks with fissured permeability and are distributed mostly on the southern side of the Tatra Mts. (Slovak side).

HYDROGEOLOGICAL STRUCTURES ALONG THE POLISH-SLOVAK BOUNDARY BELT WITH POSSIBLE TRANSBOUNDARY GROUNDWATER COMMUNICATION

Important hydrogeological structures along the Polish-Slovak boundary belt are evolved in Mesozoic rocks that can be found in tectonic units (nappes) of Tatricum, Veporicum, and Hronicum. Hydrogeological structures are combined for water balance purpose into hydrogeological regions. The important hydrogeological regions along the border are as follows (Fig. 3):

- **MG 014**. Mesozoic and adjacent crystalline rocks of the Western Tatra Mts. (Západné Tatry) in the watershed area of Orava river, VH 10 partial region of Mesozoic;
- **QG 009**. Crystalline rocks of the Western Tatra Mts. and Quaternary sediments of the eastern side of the Liptovská kotlina basin, VH 20 partial region of Mesozoic of Červené vrchy Mts.;
- **PQ 141**. Palaeogene of Spišská Magura, Lubovnianska vrchovina Upland, northwestern part of Spišsko-Šarišské medzihorie, Pieniny, PD 10 partial region of Klippen belt of Pieniny;
- **MG 142**. Mesozoic and adjacent crystalline rocks of the High Tatra Mts. and Belianske Tatry Mts., PD 10 partial region of Mesozoic of Belianske Tatry Mts and adjacent crystalline rocks of the High Tatra Mts.

According to the new proposal of delineating the water bodies, the whole hydrogeological region MG-014 is a part of groundwater body SK200270KF (dominant karst-fissure groundwater body of the Veľká Fatra, Chočské vrchy, and Západné Tatry Mts. in the watershed area of Váh). The whole hydrogeological region MG 142 is a part of groundwater body

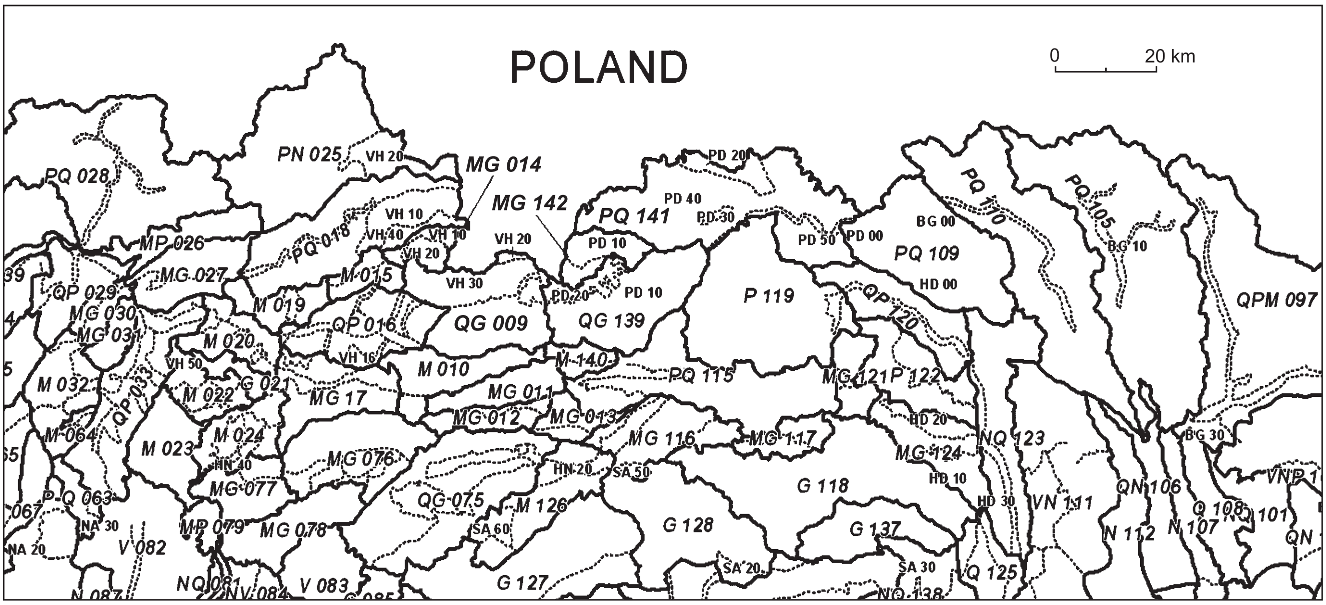

Fig. 3. Hydrogeological regions and partial regions used for by Slovak Hydrometeorological Institute for annual groundwater balance

SK200440KF (dominant karst-fissure groundwater body of the Tatry Mts. in the watershed area of Poprad and Dunajec; Malík, 2004, pers. comm.).

Hydrogeological region MG 014 consists of two partial regions: VH 10 partial region of Mesozoic (42.2 km^2) and VH 20 partial region of crystalline rocks (44.1 km^2). Low accumulation capacity and shallow circulation are predominant in the crystalline rocks. Five hydrogeological structures can be found in Mesozoic sediments (VH 10) (Zakovič, Bodiš, 1989; Zakovič *et al*., 1990):

1. Hydrogeological structure “Osobitá” — built of Triassic and Jurassic carbonates of Tatricum with adjacent crystalline rocks. The structure is discharged on Slovakian side mainly by springs, partly by hidden discharge into streams.

2. Hydrogeological structure “Bobrovec” — built of Triassic carbonates of Veporikum (area of 1.8 km^2) that continue into Poland (area of 3.8 km^2). The results of research by Zakovič (1989) showed that the main portion of infiltrated water, approximately 131 l/s (from 5.6 km^2), permeates under the Palaeogeneous sediments of Skorušina Mts., as a part of the deeper groundwater circulation in Skorušina basin (see later) or has a discharge area in Poland. Deeper circulation was proven by a 600 m deep borehole in Oravice (OZ-1) with overflow of 35 l/s and OZ-2 with overflow of 86.8 l/s.

3. Hydrogeological structure “Mihulčie” — built of Triassic carbonates of Veporicum (Krížna nappe), not exceeding 1 km^2, drained in springs with total yield of 10.8 l/s.

4. Hydrogeological structure “Furkaska” evolved in Triassic carbonates of Hronicum which is in superposition to impermeable layers of Veporikum, and in the north it sinks under the claystone sediments of Inner Carpathian Palaeogene. It spreads on Slovak side (4.9 km^2) and continues to Poland (approximately 3.7 km^2). A single measurement shown total discharge of 72.5 l/s from this structure which corresponded with specific groundwater runoff of 14.8 l/s km^2.

5. Hydrogeological structure “Mihulčie–Pribisko” — built of Triassic dolomites and limestones and basal sediments (lithofacies) of Inner Carpathian Palaeogene. The structure spreads over a total area of 5.7 km^2 and is divided into two parts. A single water balance assumption for the eastern part suggested that 21 l/s flow below the Palaeogeneous sediments of Skorušinské vrchy Mts. Single water balance in the western part gave an assumption of a greater infiltration area in crystalline rocks of the Western Tatra Mts.

Hydrogeological region QG 009 consists of three partial regions: VH 10 partial region of the east side of Liptovska kotlina valley, VH 20 partial region of Mesozoic of Červené vrchy Mts. and VH 30 partial region of crystalline rocks of Western Tatra Mts. with shallow circulation of groundwater and low importance of transboundary groundwater communication. Partial region VH 20 is a hydrogeological structure of Mesozoic dolomites and limestones that has a northern inclination and the main discharge area in Poland. Total area on the Slovakian side is 10.1 km^2. One significant spring could be found there with total yield of 6.0 l/s.

Hydrogeological region PQ 141 — Palaeogene of Spišská Magura Mts., Lubovnianska vrchovina Upland, northwestern part of Spišsko-Šarišské medzihorie, and Pieniny Mts., consists of five partial regions. From these, only partial region of Klippen belt of Pieniny Mts. PD 10 has a local significance for transboundary groundwater communication. Jurassic–Lower Cretaceous limestones (waterbearing sediments) intersect the Cretaceous and Palaeogene marlstones and flysch. Discharge of the structure (up to 20 l/s) is in springs at the contact with impermeable Jurassic marlstones.

Hydrogeological region MG 142 — Mesozoic and adjacent crystalline rocks of High Tatra Mts. and Belianske Tatry Mts., consists of two partial regions: PD 10 partial region of Mesozoic of Belianske Tatry Mts. and adjacent crystalline rocks of High Tatra Mts. (95.0 km^2) and PD 20 partial region of crystalline rocks (45.2 km^2). From 5 hydrogeological structures which can be found in the Mesozoic sediments (PD 10), the three most important are as follows (Hanzel, 1992):

Hydrogeological structure "Bujačí vrch" where a permeable bed is developed in the Triassic carbonates and in basal facies of Palaeogene sediments, with discharge area on the sub-Tatra fault in Palaeogene claystone layers. There is a possibility that groundwater permeates under the flysch sediments of Spišská Magura Mts. and Popradská kotlina basin, and thus represents an infiltration area of Ružbachy structure.

Hydrogeological structure "Javorinská Široká" is built of Tatricum Triassic carbonates with northern inclination (9 km^2). The infiltration area of this structure is enlarged by the adjacent crystalline rocks (31.9 km^2). The western border of the structure is made by a tectonic contact with crystalline rocks, just in the Białka river which represents Slovak-Polish border in this area.

Hydrogeological structure "Havran". Its western border lies on the Polish side, in Białka river valley, on the tectonic contact of carbonates and impermeable layers of "Carpathian Keuper". The most permeable rocks are developed in the Triassic "Guttenstein" limestones and dolomites in superposition, of the total area of 10.1 km^2. It is tectonically divided in two parts. The structure is discharged by springs and by hidden discharge into streams Javorinka and Białka where groundwater from carbonates flows into the Quaternary sediments.

GEOTHERMAL STRUCTURES

Based on specific properties and conditions of the hydrogeological regime, an independent layer of geothermal structures was created. From 26 perspective geothermal structures (Franko *et al*., 1995), two are adjacent to the border with Poland: Levočská panva basin and Skorušinská panva basin.

Geothermal structure Levočská panva basin is filled with the Inner Carpathian Palaeogene composed of a several-tens-of-metres thick basal conglomerate formation and an overlying flyschoid formation, of up to 4,000 m thick. The geologic structure of the pre-Tertiary substratum includes all tectonic units of the Inner Western Carpathians. The Levoča basin is separated by faults from the Klippen belt in the north and north-east, and borders the Tatry Mts. in the north-west as well as the eastern tracts of Nízke Tatry, Slovenské Rudohorie and Čierna hora Mts. in the south.

It is assumed (l.c.) that the Palaeogene in the Levoča basin, i.e. the Spišská Magura, Levočské vrchy, and the whole zone along the Klippen belt as far as Prešov, is underlain mostly by Krížna nappe (Veporicum). Evidence of geothermal activity in the area is proven by natural thermal springs (Gánovce, Baldovce, Vyšné Ružbachy) and deep wells. Geothermal activity is medium.

Geothermal structure Skorušinská panva basin is elongated in SW–NE direction, dips NE and reaches the maximum depth in the area between Habovka and Nižná. The basin dips steeply from the Tatry Massif as far as Habovka; elsewhere else its dips are gentle. The boundary between the basin and Klippen belt is clearly tectonic. The basin is filled with the Inner Carpathian Palaeogene which starts with a not very thick basal conglomerate formation overlain by a huge flyschoid formation. The Palaeogene rests directly on the Krížna nappe with outliers of Choč nappe dolomites. The cover series is likely to appear on the western slopes of the basin, at the depth of 1,500 m. The granitoid massif occurs from the depth of 2,000 m in the West, to the depth of approximately 3,000 m in the East. Geothermal activity of the area is indicated by natural thermal springs (13.0–18.5°C) and was investigated by the 600 m deep well OZ-1 (35 l/s; 28.5°C) and 1,601 m deep OZ-2 1 (100 l/s; 56°C). These thermal groundwater has origin in Triassic carbonates of Veporicum (Krížna nappe).

SUMMARY

Currently, the hydrogeological situation in the Slovak Republic is characterised by publication of hydrogeological and hydrogeochemical maps at a scale of 1:200,000, since the seventies of the XX century. They are supplemented by explanations published gradually to these days. Mapping of the whole territory of Slovak Republic is carried out (by hydrogeological regions) at a scale of 1:10,000, resulting in publication of hydrogeological and hydrogeochemical maps at a scale of 1:50,000. Up-to-date, the larger part of the state territory is covered by those maps.

Implementation of the Water Framework Directive (2000/60/EC) has resulted in delineation of groundwater bodies based on combination of former "natural" 141 hydrogeological regions defined in 1970s, and three layers of groundwater bodies (Quaternary, pre-Quaternary, geothermal). Implementation of the Water Framework Directive will improve the conditions of legislation process and protection of groundwater. Groundwater bodies existing in transboundary regions need especially intensive concern.

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