2.6.3.3. Hydrogeological position of the Hubelj spring

It can be seen from the structural characteristics, that the Hubelj spring lies in the bottom of the expressive, narrow and deep structural depression in the thrust plane of the Trnovo nappe. Springs are situated in about 70 m wide belt at the altitudes from 240 to 265 m. Water generally comes from the bedplanes, widened by corrosion. The highest springs are in the eastern part and the altitudes of springs constantly decrease towards west. Above the permanent springs there are two caves. The "Veliki Hubelj" cave has the entrance at the altitude 280 m. Eastern from the spring there is the "Hubljeva Kuhinja" cave, which is not explored enough yet. The "Veliki Hubelj" cave is a horizontal cave - a temporary spring at high water - with permanent water inside also during draughts. The hydraulic gradient of the underground water behind the spring is very high (HABIČ 1985). The reason for such position of the water level is according to HABIČ (1970) the low permeability of the Jurassic limestone. PLACER & ČAR (1974) gave an additional interpretation on the basis of the flysch basement shape near the Hubelj spring. For the correct explanation also the influence of the neotectonic movements must be considered. The arrangement of the karst rooms and the position of the underground water indicate the neotectonic lifting of the block. The karst corrosion is slower than lifting and it is not able to fuse the underground flow. The opposite process was examined at the Lijak spring, which lies in the structural lowered block with the karst channel in the depth of 90 m (ČAR & GOSPODARIČ 1988). Naturally, there are no karst features formed above the spring Lijak because of the neotectonic lowering. In this case the term "immersed karst" has also the neotectonic meaning. Finally, the determination of the depth to the impermeable flysch basement of the karst aquifer would be very important for the final explanation of the hydrogeological structure of the Hubelj spring.

2.6.4. Geologic conditions and some hydrogeologic characteristics of the Vipava karst springs

(J. JANEŽ, J. ČAR)

2.6.4.1. The aim and method of investigation

The aim of the investigation was to explain the detailed geologic position of the Vipava karst springs. The same as in the case of the Hubelj spring we used the method of mapping of lithology and structural elements. The scale of mapping was 1:5000. The lithologic-tectonic map of the Vipava area is given in Fig. 2.26.

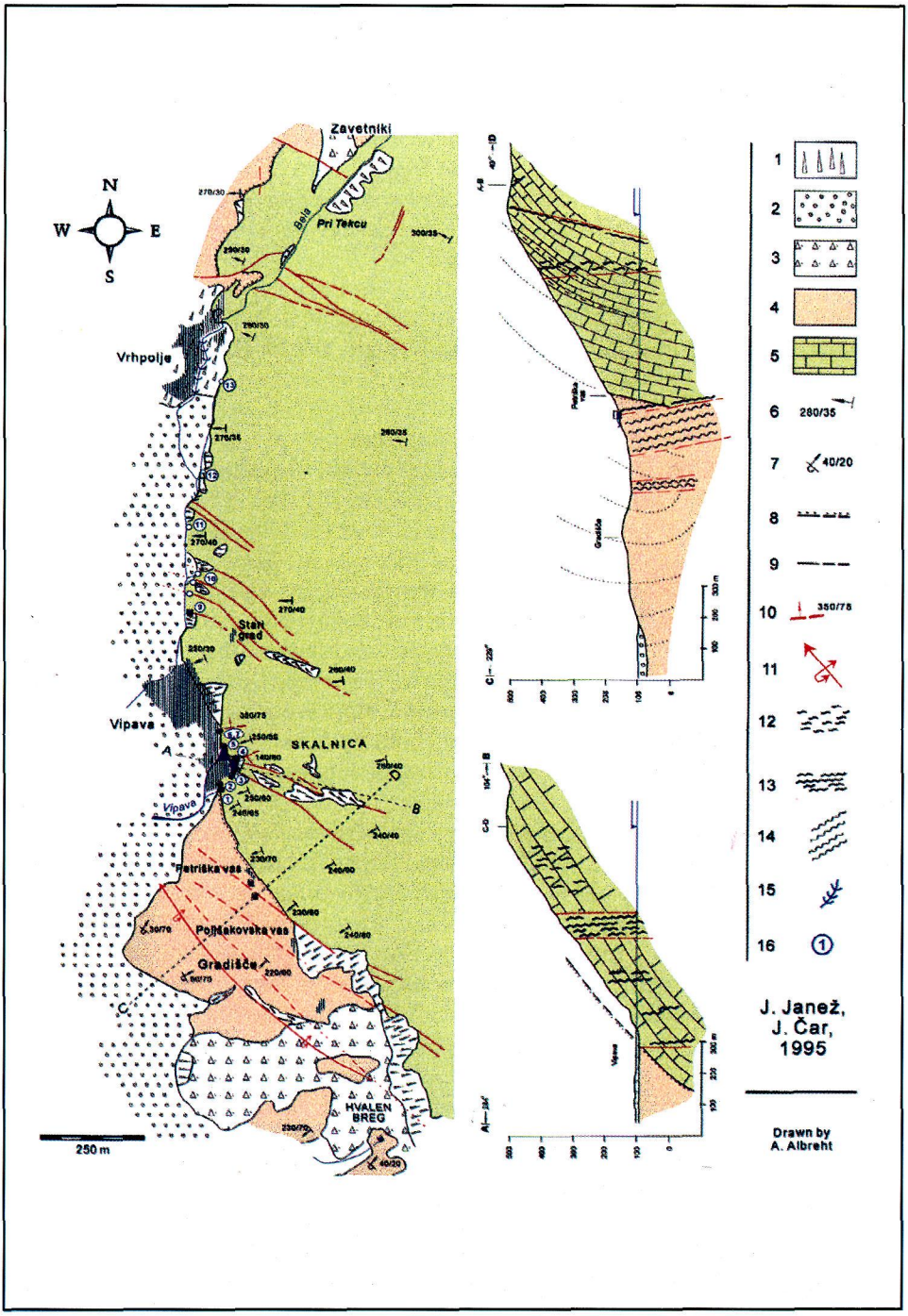
Zavetniki
Pri Tekcu
Vrhpolje
Stari gaud
Vipava
SKALNICA
Vipava
Petriška vas
Poljakovska vas
Gradišče
HVALEN BREG
250 m
N
W
E
S
A
B
C
1
2
3
4
5
6 280/35
7 40/20
8
9
10 350/75
11
12
13
14
15
16 ①
J. Janež, J. Čar, 1995
Drawn by A. Albreht

Fig. 2.26: Geologic position of the Vipava springs. 1 - Slope rubble, scree; 2 - Alluvial deposit; 3 - Periglacial limestone breccia; 4 - Eocene flysch; 5 - Upper Cretaceous limestone; 6 - dip and strike of beds; 7 - inverse beds; 8 - erosion discordance; 9 - geologic boundary; 10 - fault; 11 - axis of an overturned fold; 12- fissure zone; 13 - broken zone; 14 - chrushed zone in flysch; 15 - the Vipava karst springs; 16 - sinking of the surface water Vipava karst springs: 1 Pri Kapelici, 2 Pod Lipco, 3 Perhavčev Mlin, 4 Vipavska Jama, 5 Za Gradom, 6,7 Pod Farovžem, 9 Črncova Jama, 10-13 periodical springs (number of springs according to P. Habič 1983).

We adopt the stratigraphic data about the age and position of the mapped lithologic units from the older geologic maps (PLENIČAR 1970; BUSER 1973).

2.6.4.2. The review of previous investigation

Nanos and the springs of the Vipava river have been the objects of geologic, geographic, geomorphologic, speleologic and hydrologic investigation for over than hundred years. We count more than 90 scientific papers and treatises, that touch directly or indirectly the hydrogeologic themes. Nanos belongs to the most investigated karst areas in Slovenia.

Hydrogeologic investigations of Nanos started more than forty years ago. MICHLER (1952), SAVNIK (1955) and HABE (1963, 1970, 1976) carried out the tracing tests of the sinking streams in Pivka basin. Later, HABIČ (1987, 1989) established the connection of the Stržen sinking stream near Postojna with the Vipava springs and possible connection of these springs with the brook at Vodice village near Col.

HABIČ investigated also the Vipava springs. He describes precisely the situation of the springs, hydrologic regime, physical, chemical and bacteriological properties of the water, the water catchment area, the threat to the karst groundwater and necessary protection measures (HABIČ 1983). The water level of the springs in Vipava oscillates for 2 m, but the position of the periodical springs near Vrhpolje is 20 meters higher. The groundwater level in the background should be much higher. There are no other data about the permanent underground accumulation of Nanos. SAVNIK (1959) and HABIČ (1983) described the Vipava cave.

2.6.4.3. Geology and morphology at the Vipava springs and their hydrogeologic consequences

Nanos is an overturned anticline. The anticline axe falls gently towards north-west. Nanos is structurally a part of the Hrušica nappe. On the north-east it borders the Predjama fault. (PLACER 1981, 1996).

The western slope and the belt around Nanos from Sanabor and Vrhpolje to Vipava are built of limestone of Upper Cretaceous (Senonian) age (PLENIČAR 1970; BUSER 1973). This limestone forms the nearest background for all the Vipava springs. The limestone beds are few decimetres to one meter or more thick, with partly massive occurrence. The colour of the rock is mostly light brownish or grey-brown, rarely grey, light grey or white. Grained limestone prevails over the thin grained or thick limestone. Mostly it is more or less bituminous.

North-east from Vrhpolje in the direction to Sanabor the beds of Upper Cretaceous limestone dip towards north-west (290 - 320°). The strike ranges between 25 and 40°. Near Vrhpolje the beds dip 270 - 290° towards west and the strike of the beds is the same - mostly 30°. Southern from Vrhpolje the Upper Cretaceous limestone still dips towards west, but in town Vipava the beds start to turn towards south-west. In the northern part of the town the dip is 250 - 260°, near spring Pod Skalco 235 - 250°, and further towards Petriška Vas 235 - 240°. The strike angle ranges between 30 and 50° in the northern part of the town, 45 - 55° near spring Pod Skalco and increases to 60 - 70° in the direction of Petriška Vas.

Further to south-east the dip of Senonian limestone does not change. All the way to Hvalen Breg it varies between 230 to 240°. The strike angle is about 80°, at some places also 85 - 90°. Of course, that is a sign for the nearness of the arch-bend of the Nanos anticline. In the upper part of the slope, on the location Plaz and Pri Topolih the beds strike 40 to 80° in the direction 230 - 250°. The limestone beds are thick. Also the inliers of thin bedded marl limestone can be found. On the contact with flysch we notice few decimetres of limestone conglomerate.

According to Buser (1973) the flysch beds that lie on the Upper Cretaceous limestone belong to Eocene (Upper Cuisian and Lower Lutetian). If the stratigraphic definition is correct, then there must be an erosion discordance between both lithologic units. We do not notice any angle discordance. The strike and the dip of the flysch beds and the beds of Upper Cretaceous limestone are the same.

Flysch beds are typical for the distal type of turbidites. Few centimetres or decimetres thick beds of marl and fine-grained quartz sandstone alternate in the rock. The number and the thickness of the calcrudite and calcarenite beds rise towards south-west. On location Gradišče the Baum sequences 1 to 2.5 meters thick, can be found. It is a medial type of turbidites with clear A, B, D and E horizons, while the horizon of current lamination C appears rarely.

North-eastern from Gradišče the flysch beds dip steeply towards south-west. The position of the beds is therefore normal. At Gradišče the beds are vertical, and south-east their position is inverse, dipping 50 to 80° towards north-east. The axis of the overturned anticline is therefore well defined. It crosses the Gradišče village and joins the faults that come from Vipava.

In the short section among Vrhpolje and Zavetniki the Eocene flysch is covered with Quaternary limestone slope breccia, that is typical for the southern slope of Trnovski Gozd. At Vrhpolje the flysch is covered with limestone rubble. Along the riverbed of Bela among Vrhpolje and Vipava flysch is covered with alluvial deposits, composed of clayey thick-grained limestone and flysch pebbles.

In the western part of Nanos the slope rubble and scree cover very small areas. This shows the relative tectonic inactivity of the area. The morphology of the relief confirms this supposition. Among Vipava and Vrhpolje the western slope of Nanos is monotonous. It dips slowly toward west - with the strike angle that correspond with the strike angle of the Cretaceous limestone. North-east from Vrhpolje the Bela brook forms a narrow and up to 50 meters deep gorge in the Upper Cretaceous limestone. 100 to 150 meters above the gorge, at the location Njivce, there are remains of an erosion terrace, probably an older stream of Bela. That stream had the same direction towards south-west as the recent one. In the gorge, the limestone is weekly damaged with some fault and fissured zones. The direction of the Bela brook is mainly defined with the dip and strike of the Upper Cretaceous limestone. The limestone of the western part of Nanos has no signs of the superficial karstification, except of some shallow dolines in the initial phase of evolution. It seems, that the surface was covered with flysch in the nearest past.

Several smaller depressions in relief of the western part of Nanos, which are probably the remains of old surface water streams, have the same or similar direction as the one at Njivce location. The most outstanding remains of an old surface stream at Stari Grad above the Vipava town have the transverse Dinaric direction from the north-east to south-west. The origin of the valley is not connected with transverse Dinaric tectonic zones, but with the dip of the limestone. The third "hanging dry valley" is at Pri Topolih location above the Poljšakova Vas.

A little more crushed limestone has been mapped south from Vrhpolje. In that part the Bela brook sinks. In Vipava town the limestone is again more compact. It has only some rare fissures that are later extended by corrosion. So, the springs Pod Farovžem and Za Gradom come out from the tectonic fissures, extended by corrosion. The springs Pri Kapelici, Pod Lipco and Perhavčev Mlin drain the karst water from the vertical joints.

The limestone is tectonically modified into the crushed zone in the amphitheatrical rocky indentation named Skalnica, above the spring Vipavska Jama. The direction of the indentation is from west to east or 10 to 20° towards south-east. Its south (south-west) margin, that is morphologically exposed as an 10 to 15 meters high wall, is a fault zone with elements 30/90. The northern border of the amphiteatre has also the direction west-east, just like less visible fissures in the limestone. Inside the amphitheatre of Skalnica the rock is deformed into the crushed zone and the dip and strike can be measured only at few places.

The origin of the Skalnica amphitheatre can be induced by the tectonic deformation of the limestone, but also by a strong underground water stream towards the springs. There is a small chance, that the depression is only the result of the erosion of crushed limestone. In this case the same surface forms should come into existence also on places where there are no karst springs or karst groundwater streams; but they mostly do not. Such morphologic forms are characteristic for the surroundings of karst springs. The groundwater probably could not form bigger karst objects, because in the crushed limestone the well permeable cave break down originate simultaneously. If the amphitheatre of Skalnica is induced by cave break down, this process is in the initial phase. This agrees with our earlier ascertainment, that the relief in the western part of Nanos is still young and that the limestone was in younger geologic past covered with flysch beds. In the geologic future the result of this corrosion-erosion process will be a greater and ripe morphologic depression with overhanging walls, similar to those one at Divje Jezero near Idrija or Lijak spring near Nova Gorica.

A stronger and 150 meters wide zone of Dinaric oriented faults crosses Poljšakova Vas. It seems that the strongest is the most north-eastern fault (50/80) with 50 meters wide broken zone. Parallel to the other fault planes a dense system of fissures can be found. Flysch beds in this fault zone are strongly folded. Considering secondary tectonic deformation we suppose another Dinaric oriented fault, crossing Hvalen Breg, Žgavska Vas and Gradišče. It should be mapped easier in the limestone slope of Nanos, south-east from the investigated area.

2.6.4.4. Some hydrologic data

At the entrance in the gorge under Sanabor the discharge of Bela brook was in December 1994 and in January 1995 among 70 and 100 l/s. We estimate, that in the gorge all the way to Vrhpolje the Bela brook does not sink. Obviously it sinks in the Vrhpolje village. At the end of the village the discharge was only 2 l/s and 500 metres lower the brook was dry. The village Vrhpolje strongly pollutes the karst water, but probably only the most northern permanent spring Črnceva Jama.

Among Petriška Vas and Hvalen Breg there are some weak but captured springs. Those springs drain groundwater from calcarenite layers in flysch.