



## Transboundary Groundwater Body Karavanke/Karawanken Between Austria and Slovenia

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Large part of the border region between Republic of Slovenia and Republic of Austria is represented by high east west extended mountainous ridge of Karavanke/Karawanken. It is a range extending along the Slovenian-Austrian border for almost 150 km. Its terrain consists of long and prominent ridges, whose slopes steeply fall to the northern and southern side. Ridges are interrupted by long, deep and narrow valleys. The highest peaks reach over 2000 m above sea level. In the entire range prominent ridges with mountain meadows and forests prevail. The area is scarcely populated, the main economic activities are grazing and forestry, in some places tourism is also developing, especially winter sports centres.

Karavanke/Karawanken lies on the contact between two continental plates, the large European plate in the north and the smaller Adriatic plate in the south. When the Adriatic plate was thrusted over the European one towards the north, the collision resulted in the folding of sediments previously deposited in the space between the plates. The contact of both plates caused large lateral displacements, causing the rocks of both plates to fold and fault and then extend along the contact. This is the area of Periadriatic lineament, dividing Karavanke/Karawanken range into their north and south part.

Periadriatic lineament is large stripe slip tectonic structure along which on the northern side rocks were extruded to the east and on the southern side to the west. Along the lineament metamorphic (e.g. biotitic and feldsparic para-gneis, amfibolites) and magmatic (e.g. diabaz, granite and tonalite) rocks of various ages are present. Palaeozoic sedimentary rocks cover large part of the mountain ridge. The oldest are Silurian and Ordovician limestone on the northern border followed by Devonian ridge limestones. They are covered by molasse sedimentation in Carbon and shallow marine and river predominantly clastic sedimentation in Perm. The most abundant and with numerous varieties are rocks from Triassic age. In general they can be divided into rocks of Northern and Southern Karavanke/Karawanken deposited in different sedimentation basins. In lower part clastic rocks prevail, going into the upper part of Triassic age more and more carbonate rocks are present. In Southern Karavanke/Karawanken sedimentary rocks formed in the deeper part as well as on the carbonate platform are present, however in Northern Karavanke/Karawanken sedimentary rocks of shallower sedimentary environment are predominant. In the upper Triassic part of Northern Karavanke/Karawanken large zinc and lead ore deposits were formed. Among younger rocks only small patches are present. The most abundant are Rosenbacher coal-bearing beds of Jauntal/Juna in Austria of Miocen age where the uplift history of Karavanke/Karawanken is very well reflected. Extensive Quaternary sediments are present as slope sediments and sediments filling deep valleys.

At the end of the 20th century decision was made to construct a 7,8 km long road tunnel through Karavanke/Karawanken between Hrušica on the Slovenian side and Rosenbach/Podrožca on the Austrian side. It was established already during the construction that waters flowing from the tunnel represent an important water resource. In Slovenia some of these springs were captured and led into the water supply network, while in Austria they remained well protected water resource for the future. Such important water resources require protection, which in turn demands knowledge about their recharge areas. This fact stimulated authorities of both countries to support the beginning of hydrogeological investigations in the west Karavanke/Karawanken region through

the common “Drava/Drau water-management commission” and subcommission “Drinking water reserves of Karavanke/Karawanken mountains”.

During hydrogeological investigations detailed hydrogeological mapping of the whole Karavanke/Karawanken ridge was made. Sampling of important springs and low water discharge measurements followed this stage. Samples were taken for basic chemistry and stable isotope determination of water as well as some more sophisticated analyses (e.g. isotope analyses of noble gases) in the area of mineral waters appearance. Important part of investigations was production and compilation of new geological map based on older published and unpublished geological maps from both sides of the state border. This map represented background for the definition of hydrogeological and other detailed and specific maps (e.g. risk potential and vulnerability maps). Based on these results basic hydrological balance of the area was calculated, identification of cross border flow was performed and finally protection measures were suggested.

A large part of Karavanke/Karawanken is built from karstified carbonate rocks of limestone and dolomite with underlying Paleozoic limestones. The largest part of karstified rocks lies in the area of North Karavanke/Karawanken, the Košuta unit and the Kamnik-Savinja Alps. About 3600 springs were recorded in the area of Karavanke/Karawanken on both sides of the Austrian-Slovenian state border from 1990 to 2002. For each spring, water flow, electrical conductivity and water temperature were determined. Mostly the springs have a small water flow. Only some very large springs flowing from a karstic aquifer were found to have a recharge area extending across the state border.

In 2004 based on the bilateral agreement between Republic of Slovenia and Republic of Austria the common transboundary groundwater body Karavanke/Karawanken was defined. The body is defined according to the Water Framework Directive requirements and extends to the area of the main border ridge. It is divided on areas, where prevails the surface water outflow, which depends only on the surface form and areas, where groundwater outflow is present. Within the area of common water body of the Karavanke/Karawanken five cross-border aquifers were determined.