THE PRESENTATION OF THE MONTELLO HLL

ABSTRACT

The Montello hill is located in NE Italy, it has an extension of 59 sq km with 89 different caves and springs surveyed. Due to karst erosion, the surface is characterised by more than 2000 dolines, and collapse dolines. The particular rock type that builds up the hill, has an average thickness of 600 to 700 m and is known as conglomerate (pudding stone). The karst erosion has created the second longest cave in the world in this type of formation (more than 6700 m long) and many other ranging from a few meters to 400 m. The main inflow into the aquifer is due to rain infiltration (0,35 m/year). Springs are concentrated along north, east and south borders totalling an average of 2,5 to 4,5 million of cum/year. The outflow of the karst aquifer ranges from 10 to 12 million cum/year, mainly entering the porous alluvial aquifer on the east side. Water quality is still good, due to lack of pollution centres.

GEOGRAPHY AND GEOLOGY

The Montello Hill (Colle del Montello) is a small relief, which is located in the north-west part of the Veneto Region. It covers an area of about 59,3 km², extending between 80 and 370 metres of altitude above sea level. From the north and the east side it is enclosed by the valley of the Piave River. Whereas in the south it is connected with the High Plain of Treviso, that is a part of the large Veneto Plain.

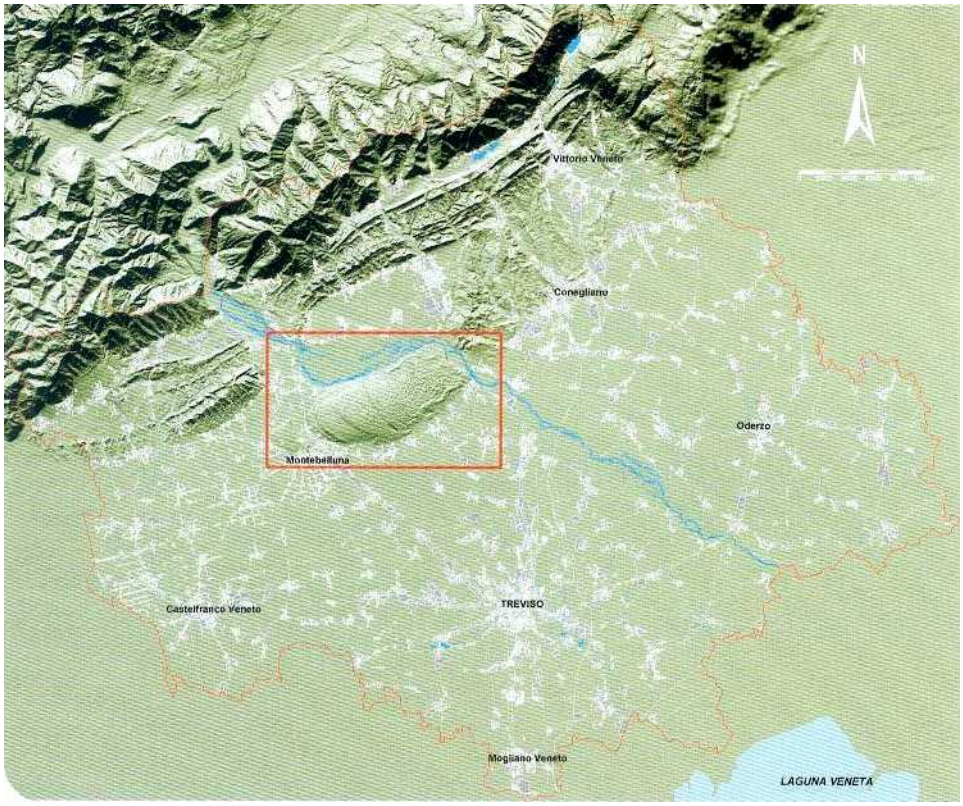

Fig.1 The province of Treviso, which regards the Montello Hill (elaborated by file DTM,RV)

The study area has a more or less elliptical shape, which extends in NE-SW direction. This particular shape resembles "turtle's crest", which is a result of the action of the karst phenomenon. In spite of small dimension (12,5 x 5 km) the Montello Hill is spread for 5 administration zones: Nervesa, Giavera, Volpago, Montebelluna and Crocetta (fig.2). In fact this elliptical hill is only 20 km from Treviso in the north-west direction, however the largest part of the region is covered by dense arboreal vegetation mostly represented by oaks.

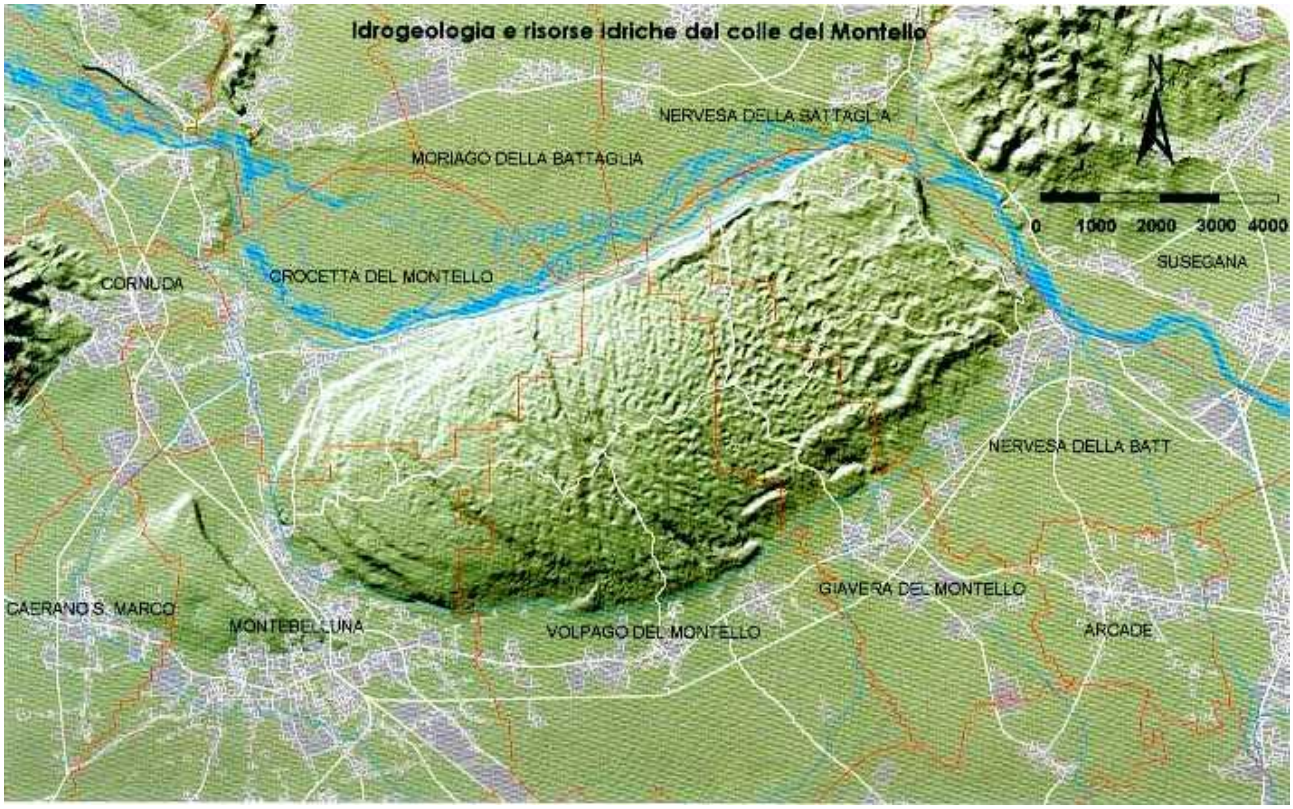

Fig.2 The Montello Hill with the administration confines.

The most interesting occurrence in this region is a particular phenomenon of karst capability of the emerging rocks. The Montello Hill has been modulated by rainfall, whose water tends to infiltrate rapidly underground, through the carbonate rocks (limestone and dolomie). Due to those favourable rocks conditions (high solubility and dissolution), the water move down, affecting the carbonate formation for several hundred metres, creating a complex system of fissures and open cavities (fig.3). On the other hand many of the largest valleys correspond to the excavation directions of the glacial cover found of the top of these surface during the Pleistocene. However the glacial erosion did not remove the karst formations.

Fig.3 The Castel Sotterra caves, with form of deposition made by the underground water in carbonaceous rocks

As follows, the particular morphology of the hill, occurs as a result of the action of two morphogenetic agents which have glacial and karst roots. Indeed we can admire the numerous valleys (for example valley of Acqua, Maor, de la Murada, Pomere and Padovana), hollows, sinks, springs and other typical forms. Apart of these, there are a lot of valleys, which occasionally merge to create large basins, especially in the central and in the east part of the zone.

Actually there is not an hydrographic network, which is limited only in the rainfall period, that is a typical phenomena of karst configuration.

Only at the end of the two slope that come down from the crest to the North-Side , to the Piave river and to the plan, there are proper drainage lines. Due to the erosion of the mentioned river during the northern and oriental sides the hill ends with high slope (also close to 20 m), in the western side it formed river terrace. In the central area, caused by karst phenomena, several drainage basins are observed. They are fragmentised and without huge valleys, and are often coincident with dolines.

In the West Side of the Hill is located the other hill of Montebelluna, which is not included in this study. From a morphological point of view, the Montebelluna one, has a triangular shape with a summit of 30 metres above a plain, and it extends for about 1 km². The genesis of the plain, which is spread between two hills, Montebelluna and Montello, is not clear. According to a first

theory the plain was formed by the action of the Piave River which cuts the turtle's crest and separated it into two summits, while a second theory says, that this separation would have been done by the tectonic lineament formation which has created a depression, concern to the valley.

CLIMATE AND HYDROLOGICAL FEATURES

The Hydrographic Office of Treviso collected the data temperatures and the data rainfall with a measure station in Sernaglia and Montebelluna, for the 1921-50 years period. The results indicate in 13º C the annual mean temperature, and 1050 mm the annual mean rainfall.

Presently, there are two new stations: S.Angeli and Nervesa, but, in spite of that, data are not enough to give a reasonable annual average (fig.4).

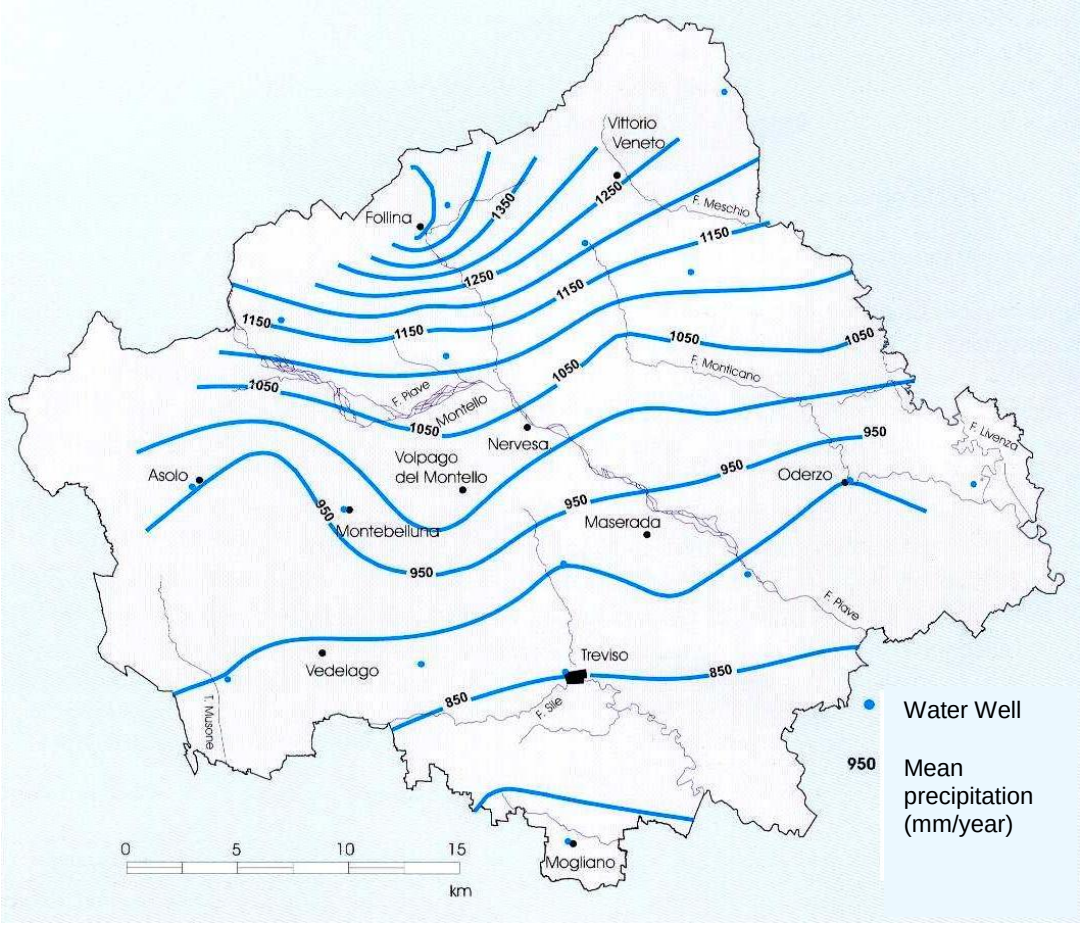

Fig.4 The map of the isohyets for the Treviso Province (for the medium period 1921-50, elaborated by Hydrographic Office).

GEOLOGICAL AND STRATIGRAPHICAL SINGS

In this paragraph we explain briefly the geological aspect of Montello. The Montello Hill is formed by a sequence of sub-orizzontal conglomerate with a thickness ranging between 10-15 m.

5It can find these following rocks:

-Clay more or less marly

-Sandstone

-Cemented calcareous puddings with the gravel and pebbly elements, the diameter oscillating between 30-40cm, but can be also found the flintstone, porphyry, gneiss and granite.

Exemple of well in the Velpago (max. depth 3442m)

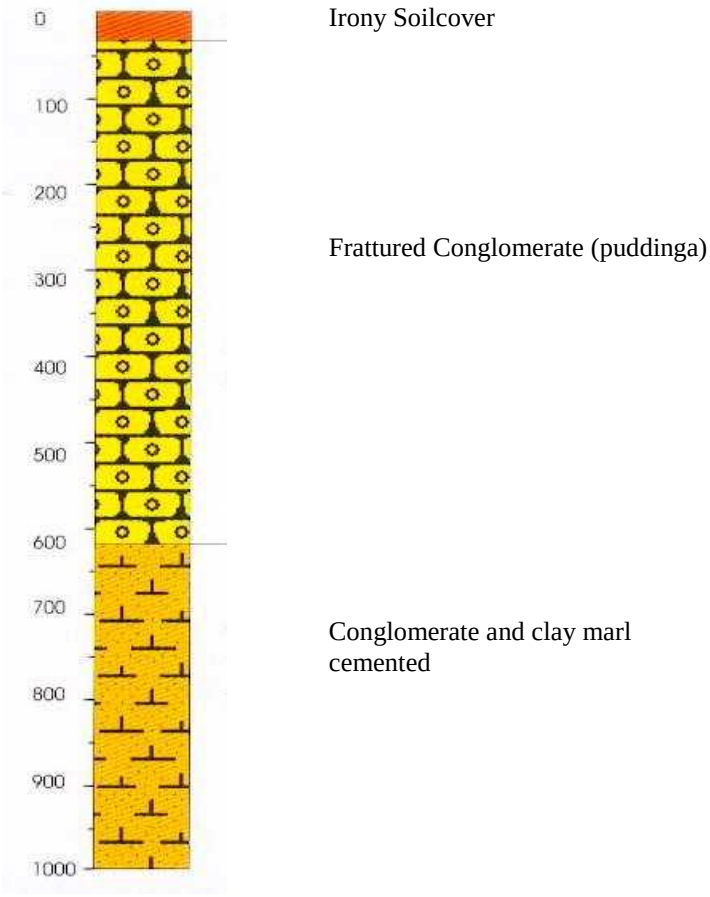

Fig.6: Under these formations, there are marls clayey with marine's mikrofossil to the lower eocene, which reach the 3400 m. The well was perforated to 3442 m, and on the 1250 m were found salat water and gas.

The rise of the layers is gently, and create the anticline plain with the axes in accordance to the orographic dorsal. This particular structure is formed by the compression of the rocks from NNW to SSE. These slow movement series, in a mostly rigid structure, caused the rising and

fracturing of this plain, generally in NNW-SSE and NNE-SSW direction. Finally, the thickness of these conglomerate (puddinga) reach 600-700m (petroleum wells Volpago and Cavalletto shown in fig.6).

This formation was done in the Messinianum Period. In this Era the base level of what we know today as Mediterranean sea, start to decrease. This event, which continued for about one million years, done accented erosion and lot of deposits of materials during the costs lane, due to the high sloping. Afterwards, when the connection with the ocean reopened and the sea level increase, the deposition of material started to stop. The alternation of these processes during the eras, caused further variation of the landscape. The substrate, indeed, represent typical and very accentuated erosion form, and morainal deposit through the western side.

KARST PHENOMENON

Karst phenomenon is an event that produces erosion and chemical dissolution of some type of rocks, typically caused by surface waters. Depend of The high karst solubility of the emerging limestone and the presence of a well-developed system of fractures and cracks, are the fundamental caracteristics to complete this particular type of morphology.

According to the surface's shapes we can distinguish different forms as: valleys, sinks and wells, springs and underground hollows. Many of the valleys are aligned on the bottom of depression with the various depths from 2-3m to 20-30m. These valleys with U-shaped profile were formed during the Pleistocene, when the glacial erosion took place. Whereas the previous forms are represented through the dolines of collapse that were made by karst formations. These forms we can notice in the north-east part of the zone, in eight cases, which make evident the hydrological stratum.

The surface karst formations are frequently in central part of the hill, the east part of the Val Maor and Val Padovana. In the West Side we have a lot of valleys, whereas the springs are located through the north and east perimeter of the Montello hill.

BRIEFLY CHARACTERISTIC OF CAVES

The most part of the underground caves is situated between 120-180 metres with the average number of 145m. The inside difference in height between an entrance and a bottom of the cave in general are smaller than 10 metres. Only in one case this difference is about 125m (Castel Sotterra). This cave is also the longest one, which reach the length of 6752m! But in general, the average length of caves is about 161m and major part of the caves has the length less than 2500m.

THE CARTOGRAPHY AND SIMBOLOGY

To comprehend and better analyse the area, Treviso local administration created, a geolitologiacal, and a hydrogeological map, done on topographical and aerophotographical base, and on the ground and underground measures,. following Guidelines of the Geological National Services (SGN) for simbology.

GEOLITOLOGICAL MAP

The map presents various types of rocks which emerge on the surface. The base is made of one rocky formation which crops out only in few zones. Here we can notice well cemented calcareous pudding, with round elements (approximately 1-40 cm of diameter).

The litology of each, individual constituents relates to the catchment basin rocks, which are formed by the Piave River and the Brenta River. The most frequent rocks are: limestone, flint, and a major part includes the dolomite and other acid rocks. The secondary position have the basaltic rocks which crop out only spontaneously. The cement is mostly calcareous, whereas matrix is consisted of the fine-sand.

The rocky materials which were transported here, have generally an approximately plain slopes except the north slope and the southern slope, that has immersion towards south/south-est. Due to the rocks rigidity and a fast uprising process we can notice that the fracturation here was very intensive.

The strong alteration with a well developed vegetation have created a soil rich of iron.

The intensive alteration have also cancelled the base of calcareous pudding. Only in some small and more recent parts of the region can be found this undisturbed formation of calcareous pudding. These zones spread:

- along the north-east side, with slope of 15-20 m, and of 4 km of length,
- along the north-west side, where is continued the previous slope with decrease from north-east towards south-west,
- along the main valleys, which run across the hill from north-west to south east (Val Maor, Val Padovano, Val di Cal Traversa),
- along the slope with some erosion’s terraces, emerge between 140-300 m of altitude, on the west side,

Below the southern and northern sides is situated the particular kind of deposits which are constituted of alluvial clay with a strong organic component.

On the west side of the hill, between 140-300 m of altitude, along the terraces there are 10-15 m of moraine's accumulations (sounding for the new hydrogeological reservoir per Consortium Acq. Schievenin).

The simbology of map arrive at the end of the plain, where it change to deposits not cemented, with elevated granulometry.

HYDROLOGICAL MAP

The construction of the hydrogeological map is based on the qualitative valuation of rock's permeability. After having collected the geological and hydrogeological data related to the area in question, it can subsequently defined the hydrogeological units with similar permeability features. The next step was the elaboration of the hydrogeological map, including also the typical elements of hydrogeology as: springs, hollows, wells and reservoir, idiomatic stations, the footprints of the hydrogeological basin and the direction of flow from surface and from underground.

Hydrogeological components which have been received from the lithological map were simplify and were subdivided into three general units:

-calcareous unit (AP) - it consists of hills with high permeability: about 30 m/hours,

-alluvial unit (AP) - which consists the dissolution material, a silt which was transported with water of Piave River, and here is includes also the deep acquifer (in the south part of the area) with elevated permeability for porosity,

-colluvium unit (IM) - it consists tinny material, as silt and clay, that are considerate impermeable.

HYDROGEOLOGICAL BASINS

Reconstruct the map of karst hydrogeology and the hydrogeological resources of Montello hill was possible by directly measured the level of the water course both in the caves and in surface. Also the numerous topographic caverns and experiments of traces, which have been done in the past, confirm the first hypothesis of this map's look.

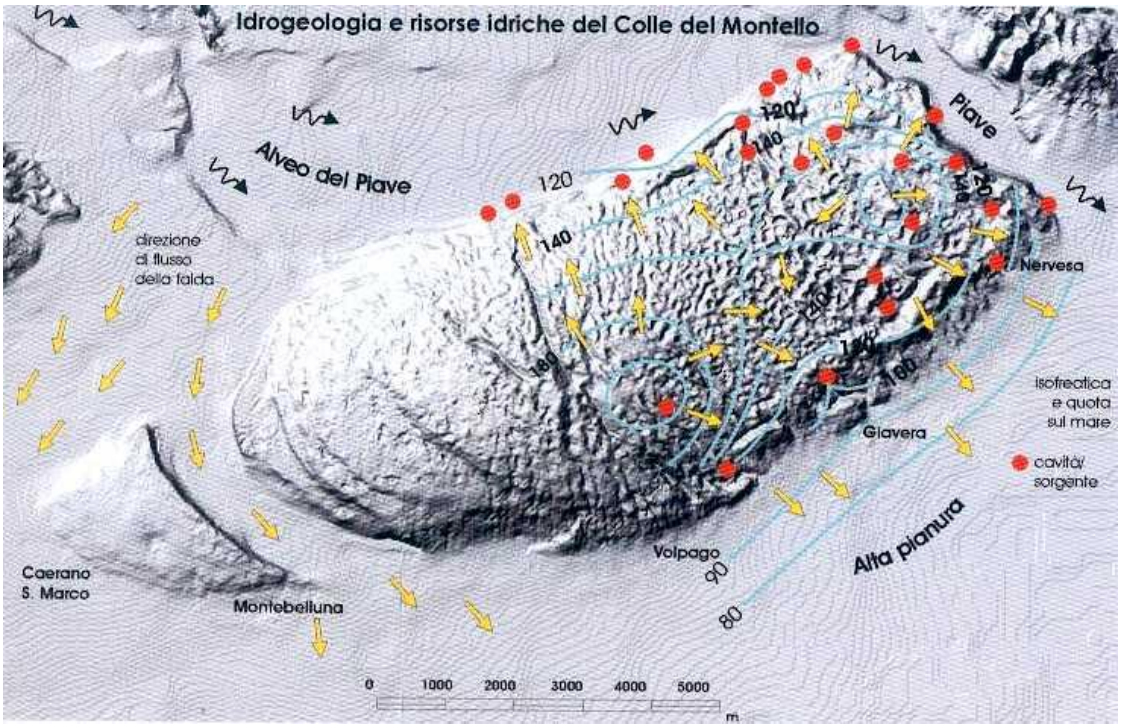

Fig.5 Hydrology and hydrogeological resources

The movement of the piezometrical surface is reconstructed in base on the hollows measures. We can notice the central watershed, which correspond more or less to this orographycal, from which the flows run in direction south-east and south-west. The watershed comes down slowly what confirm its dependence from the regime of the layer. The important things is that this zone is referred to the heterogeneous reservoir, whereas in the south is the surface contented.

In general the main features are:

1. The piezometria shows that the watershed corresponds more or less the average line of the hill, with gentle modification towards east and south-east, from where the underground flows run to south or to north,
2. The gradient towards the plain passes from 0,06 in Montello to 0,02 to south-east, whereas altitude are from 120 to 200 m above the sea level,
3. The numerous springs in the north and the east sides shows that the Piave River creates the present base level along these two sides; some hydrogeologic evidences make think that part of the fluid could be under the impermeable unit that surrounds Montello's foots.
4. The central watershed comes down slowly in the south-east part of the S.Angeli (Fontana Irea, Fontana del Sordo), and when the regime of the water is diminish it is possible to have the local variation of the flow.

5. Often the relation which exists between the development of galleryand and the network of the fractures on the surface, is not always evident, as is normally on the surface.

6. In general, exist a lot of hydrogeological basins, which are connected, with a local development of the underground karsic process. On the hydrogeological map there are marked some largest basins:

- Sub-basin of Conca (it extents approximately 5,6 km²) – it is connected to the Castel Sotterra Cave, where are a lot of tunnels from which water is carried onto Conca Sping.
- Sub-basin of Forame (it extents approximately 6 km²) – it includes series of caves from which water goes out through the Forame Spring.
- Sub-basin of Abbazia (it extents approximately 1,5 km²) –it is situated in the East side of the previous one and is not far away from Nervese cemetery. The spring is obviously called Abbazia Spring.
- Sub-basin of Casseon (it extents about 1,3 km²) –this spring is near the Piave River and is reinforced by water from stream that has its origin near the Posan Cave.
- Sub-basin of Tavoran Grande (it extents about 1,2 km²).

Almost every of these springs are independent and water come from one principal karst channel. The maps show that the karst morphology is here well expanded, there is not overabundance of caves, of small dimensions and not natural dryness.