

Karst caves and hydrology between geodesy and archeology: Field trip notes

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ABSTRACT

The Geodynamics-Earth-Tides-meeting-2016 was held in the Karst, the origin of geologic karst-formation. Surface-rivers are absent, and water flows in channels over distances of 30 km, forming subsurface caves. Geodetic observations allow detecting caves and sense hydrologic flow. The Karst water had been recognized before Romans as provision for man and livestock. Proto-historic remains near the mouth of the underground river suggest the water outpouring from the Karst was associated with deities to be worshiped. Here the geodetic and cultural aspects of the Karst are summarized, illustrating the field trip that had been offered to the participants.

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1. Introduction and field trip summary

The field trip of the meeting was held in one afternoon of June 8, 2016, and included the visit of the Grotta Gigante Karst cave with its geodetic instrumentation and the visit of the mouth of the Timavo river at the base of the Karst Plateau, with its archeological remains. The archeological visit included the remains of an early Christian church and a Roman hostel. The distance from the Grotta Gigante cave, below which the underground river flows to the mouth of the river, is approximately 30 km. In Fig. 1 the itinerary is shown.

The field trip crossed the Karst Plateau, belonging to the so-called “Classic Karst”, from which the geological term “karstic”, related to the dissolution phenomena in carbonatic rock, took its origin. The plateau is constituted by a thick carbonate succession from Early Cretaceous to Eocene, with a thickness of 2000 m,

partially covered by Early-Mid Eocene turbidite flysch deposits [2]. The tectonic setting is an anticlinorium, with altitude a.s.l. decreasing from SE to NW, where the platform disappears, buried below the alluvials of the Friulian plain. The carbonate succession is constituted by limestones, dolomites, breccias and bituminous limestones, with a rich fossil fauna [3]. Karstic features are present in all the formations, from the karren, and sinkholes of the surface to the canyons, chimneys, and caves of the depths. The sinkholes, which are collapsed caves, are well seen in digital terrain models. Fig. 1 shows the alignment of the many round depressions. They range from a few meters to about 300 m in diameter.

The field trip followed one portion of the course of the underground river, which carries the name Timavo, which flows for about 40 km below the surface, hidden by the white rocks and the karstic scrub of the Karst.

The precise path of the river is still unknown: born in Croatia on the southern side of Mount Snežnik, it flows through western Slovenia, and it disappears underground and flows through the Škocjan Caves (location see Fig. 2). In its Italian course, it rapidly deepens, until reaching a level of about 8 m above sea level, at which it gently flows towards the springs at San Giovanni di Duino. In Fig. 3 the river is depicted as it can be seen in the Škocjan Cave. Along its flow it can be seen at the bottom of some of the more than 2000 caves known in the so-called “Classic Karst”. Fig. 2 shows the position of all known caves in the Italian Karst. The color code of the

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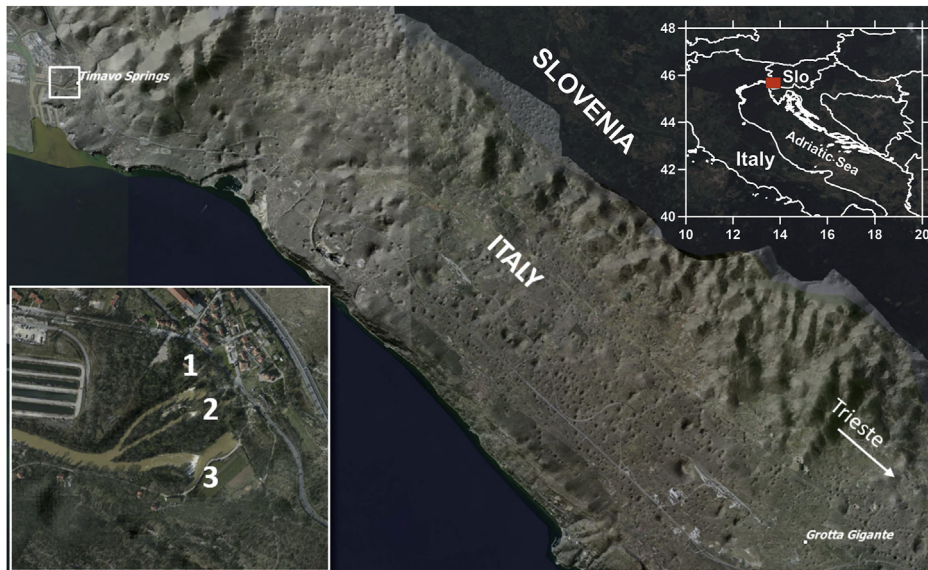


Fig. 1. Map of the itinerary from the Grotta Gigante cave to the mouths of the underground river Timavo (Timavo Springs). The digital terrain model derived from laser-scan data (acquired by Regione Autonoma Friuli Venezia Giulia [11]) is shown together with the satellite images (Microsoft Bing Maps). The many sinkholes are well seen and are presumably aligned with the flow direction of the underground river. The inset displays a detail on the Timavo Springs: the three numbers 1 to 3 refer to the three water mouths shown in Figs. 10–12, respectively.

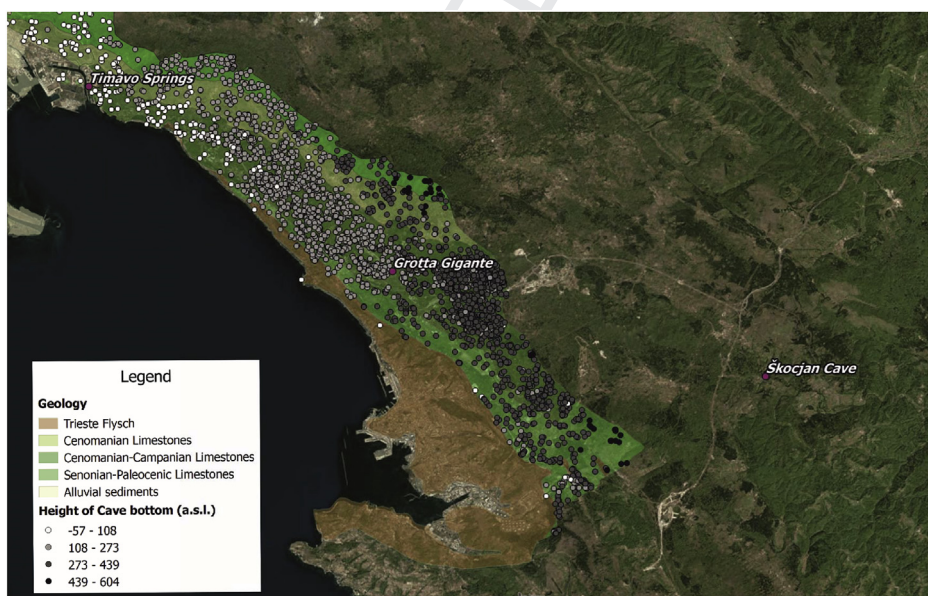


Fig. 2. Map of the Karst showing the outcropping Geological formations in its Italian part [4] and the known caves, reported with circles, according to the Friuli Venezia Giulia (Italy) kadastrale catalog [5]. The color of the circle refers to the height of the cave bottom on sea level. A SE–NW trend is evident, that could be interpreted as a general indicator of the flux direction in the Karst system, bound to the tectonic setting of the layers. The increase in water level after strong rainfalls reaches over 100 m. Satellite image from Microsoft Bing Maps.

dots is related to the deepest extension of each cave, which is a proxy for the position of the deepest local water flow. In fact, the extension of each cave is governed by the hydraulic flow. It is seen that the darkest dots are limited to the South-East, then the depth gradually increases, until reaching depths even below sea level close to the Timavo mouths in the North-West. The biggest depth gradient is found in the South-East. In a selection of these caves, the river level is monitored continuously. During river floods, the hydraulic head increases its level by over 100 m, as has been demonstrated by the pressure gauges. The pendulums of Grotta Gigante and the collocated GPS station record the high stands of the

underground river through characteristic tilt and displacement, respectively. The underground river appears again through four springs at San Giovanni near Duino, takes an overland course 2 km long, and outflows in the Gulf of Panzano (part of the Gulf of Trieste), 3 km southeast of Monfalcone, into the Adriatic.

2. The Grotta Gigante cave

The Grotta Gigante cave, situated near Borgo Grotta Gigante, in the municipality of Sgonico (Trieste), is the most renowned among the caves in the Italian part of the Classic Karst, the other being in

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