

5.7.11 *Human influence on the karst water of the Nerja cave, Malaga, Southern Spain*

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5.7.11.1 *Site description and hydrogeologic settings*

The karstic underworld is a domain which has been traditionally studied from a speleological or scientific approach (Trombe 1952) but in the last few years the interest is also economic (Mangin & d'Hulst 1995, Huppert et al. 1993). Everyday, many cavities are visited by the public and constitute important economic activities in the region where they are situated. The human visits produce impacts in the underground environment: variations of the climatic parameters (temperature, humidity, CO₂), contamination and changes of the physical parameters of the groundwater and rock alteration (Cigna 1993, Pulido-Bosch et al. 1997). This contribution deals with the human impact on the environmental parameters and on the drip water in the Nerja cave, a touristic cave situated in the south of Spain (Andalusia), 50 km to the east of Malaga city and less than 1 km from the Mediterranean Sea (Fig. 5.51). The Nerja cave extends through a series of chambers and galleries to a total of almost 5 km, with a difference of height of 70 m and occupying a volume of over 300,000 m³. Its shape is elongated in a more or less N-S direction and practically horizontal. The cave entrance is situated at 158 m altitude. From a geological standpoint, the cave is situated in the Almirajara unit belonging to the Alpujarride complex of the Internal Zone of the Betic Cordillera (Avidad & García-Dueñas 1980, Sanz de Galdeano 1986). This complex has two lithological formations, represented in the geological sketch of Figure 5.51. The lower one is made up of metapelites (schists and quartzites), attributed to Paleozoic age. The upper formation is carbonated: white dolomitic marbles towards the base and blue calcareous marbles towards the top, with discontinuous metapelitic intercalation, dating from the middle to upper Triassic. The cave is developed over the dolomitic marbles which have a dense fissuration. Outside the cave, detrital Neogene deposits outcrop discordantly over the Alpujarride materials (Fig. 5.51). Karstic forms (karren, dolines, sinkholes) hardly exist in these carbonate materials. The Nerja cave is a major exception. The karstification process which gave rise to the cave occurred throughout the Pliocene and the Pleistocene. During the temperate and hot periods of the Quaternary age enormous quantities of speleothems were generated (Durán et al. 1993). The cave is actually in the unsaturated zone of the aquifer, several metres above the water table (Andreo & Carrasco 1993a), because of the neotectonic activity and uplifting along of the faults which limit the aquifer at the south.

5.7.11.2 *Tourism*

Since its tourist habilitation in 1960 the cave is one of the most visited natural sites in Spain, with 500,000 visitors per year throughout the period between 1988-1996. The monthly distribution is very similar for the different years (Fig. 5.52). The numbers of visitors vary between 200 and 3500 daily; some days increasing to 5000. The