THE BASALTIC CANYONS OF MOUNT ETNA

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Abstract

Present work deals with the description of the two basaltic canyons of Alcantara river and Simeto river, respectively located NE and W the Mount Etna Volcano.
The authors describe the main hydrological, geological, morphological and naturalistic features of the canyons; a final section is specifically dedicated to water pollution and environmental protection problems.
The discussion of the above mentioned themes highlights two important conclusions:
1. The morphology of the Simeto canyon is very similar to other karst canyons of Sicily (Pollina river or Faguara creek, in the Madonie Mounts);
2. Water pollution of Simeto rivers is very dramatic and absolutely incompatible with the presence of two natural reserves that theoretically should protect this area

Introduction

The Mount Etna Volcano is borded, eastward and westward, by two of the main rivers of Sicily, respectively the Alcantara and the Simeto rivers that, eroding the quaternary lava flows encountered along their courses, have generated two of the most important canyons of the island (see Fig.1).
These two features are of great naturalistic interest, so they have been protected by sicilian governments by the institution of two natural reserves.
In particular, as it happens in other karst areas, where canyons and caves constitute unique natural systems which development is driven by strictly related geomorphological processes, the Mount Etna Volcano represents a very complex pseudokarst system, where underground and surface features sometimes present peculiarities due to their lithological origin, but in other cases they show a strong morphological convergence with limestone karst morphologies.
Despite their importance, the scientific knowledge of these areas is very poor and one of these, the Simeto river canyon, presents a lot of environmental problems due to water pollution and illegal solid material discharge.
The aim of the present work is to contribute to the general scientific knowledge of these two environmental systems, discussing their hydrological and geological-geomorphological characteristics and focusing the attention over the environmental preservations problems.

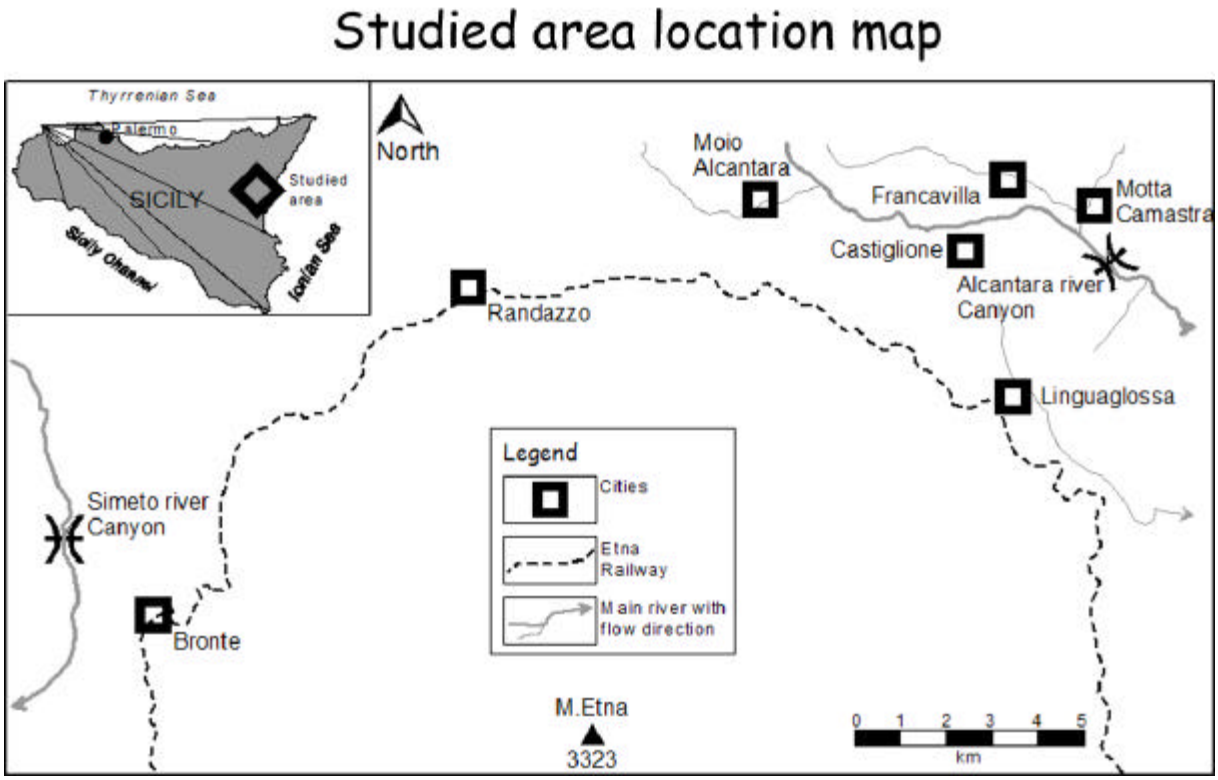

Fig. 1 - Studied area location map.

Hydrology of Alcantara and Simeto rivers

Figures 2 and 3 shows respectively the main climatic and hydrological parameters of the studied areas, acquired in the nearest available station of the ITALIAN HYDROGRAPHIC SERVICE (1986-1994).

The yearly average distributions of rainfall amounts and temperatures are in tune with the general climatic asset of Sicily: a Mediterranean climate with a mild rainy winter season and a dry hot summer.

The effective rainfall amount, with this term defining the difference between rainfall and evapotranspiration amounts, is very low, or equal to zero, during the entire summer and part of spring and autumn. The above mentioned figures shows the average monthly values for the two rivers; evapotranspiration has been calculated using the HARGREAVES (1994) formula.

From April to September evapotranspiration losses exceed rainfall amounts, so there is no water to supply surface discharge. This theoretical situation is confirmed by the monthly values of Alcantara river flow rates (no measuring stations along the Simeto river), that shows a one month shift respect to the corresponding values of precipitation. This shift is probably due to the underground waters that are also responsible, with the anthropogenic contributions (sewer effluents), of the minimum flow rate (less then 1 m^3/s) registered during August; in the same period the Simeto river presents a discharge of two magnitude orders less only in exceptional rainy years; in a normal hydrologic year its bed is completely dry. This different hydrological summer regime is due either to the hydrogeological asset of Mount Etna Volcano, which impermeable sedimentary basements dips eastward and drives underground waters toward the Alcantara river, either to anthropogenic causes, as better discussed in the environmental paragraph.

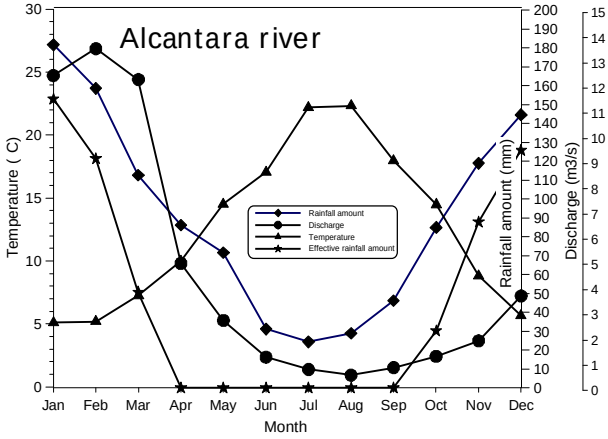

Fig. 2 - Hydrological parameters of Alcantara river (average values for the period 1986-1994).

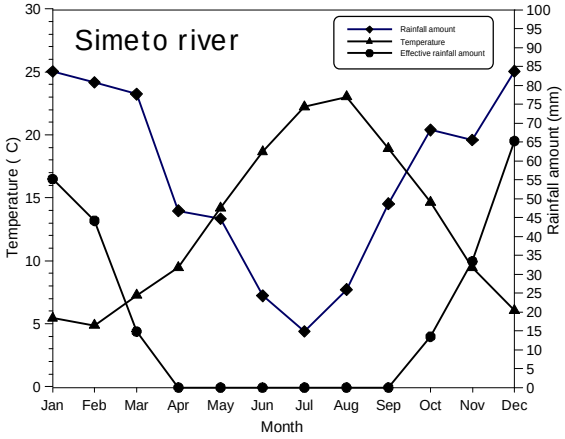

Fig. 3 - Hydrological parameters of Simeto river (average values for the period 1986-1994)

Geological and geomorphological asset of Alcantara and Simeto canyons

The geological context of the two studied canyons is showed in the figures 4 and 5, completed by the longitudinal sections presented in Fig. 6.

Both the canyons have been eroded into the Quaternary alkali basalts of the Mongibello volcanic complex (ROMANO et al., 1983): the Alcantara canyon in the Holocenic lavas (recent Mongibello), the Simeto canyon in the Pleistocenic ones (ancient Mongibello).

In both cases we can define the two features as “antecedent canyons”, because the flow direction of the rivers doesn’t vary during the crossing of the canyons themselves.

The longitudinal profiles of the two canyons are not very similar, reflecting the different mechanical properties of the lava outcroppings where they have been eroded.

The Alcantara canyon presents a series of little waterfalls, with an height no higher then 2/3 m, regularly distributed along its entire development. On the contrary, in the Simeto canyon we can found a main waterfall 8 m high just at its entrance; the longitudinal profile is then horizontal, interrupted by two minor waterfalls respectively 1 and 5 m high.

These differences are probably due to the characteristic columnar fracturing, founded in the holocenic lavas and only in a very reduced form in the ancient ones. Despite of their younger geological ages erosion rate, driven by the columnar fracturing, is faster and more homogeneous in the first ones. This is confirmed also in the Simeto canyon, where at the passage from the pleistocenic to the holocenic lavas, just at the end of the canyon itself, we assist to a sudden increase in the river bed width.

Columnar fracturing is also responsible of the semblance of the rockwalls that confine the river inside a basaltic canyon: where fracturing is present and well developed the rockwall surface is articulated in a multitude of minor surfaces with various aspects and slopes, corresponding with the faces of the polyedra formed by the fracturing system. When the columnar fracturing is absent or poorly developed, the lava outcropping is more resistant to fluvial erosion, waterfalls are generated only in correspondence of the hardest portion and the canyon rockwalls are polished in the same way we can find in a morphology developed in other lithologies like limestones, sandstones, etc.

In other words, due to the presence of a common morphogenetic agent, that is the fluvial erosion, we observe in this case a very evident morphological convergence with features formed in different lithologies.

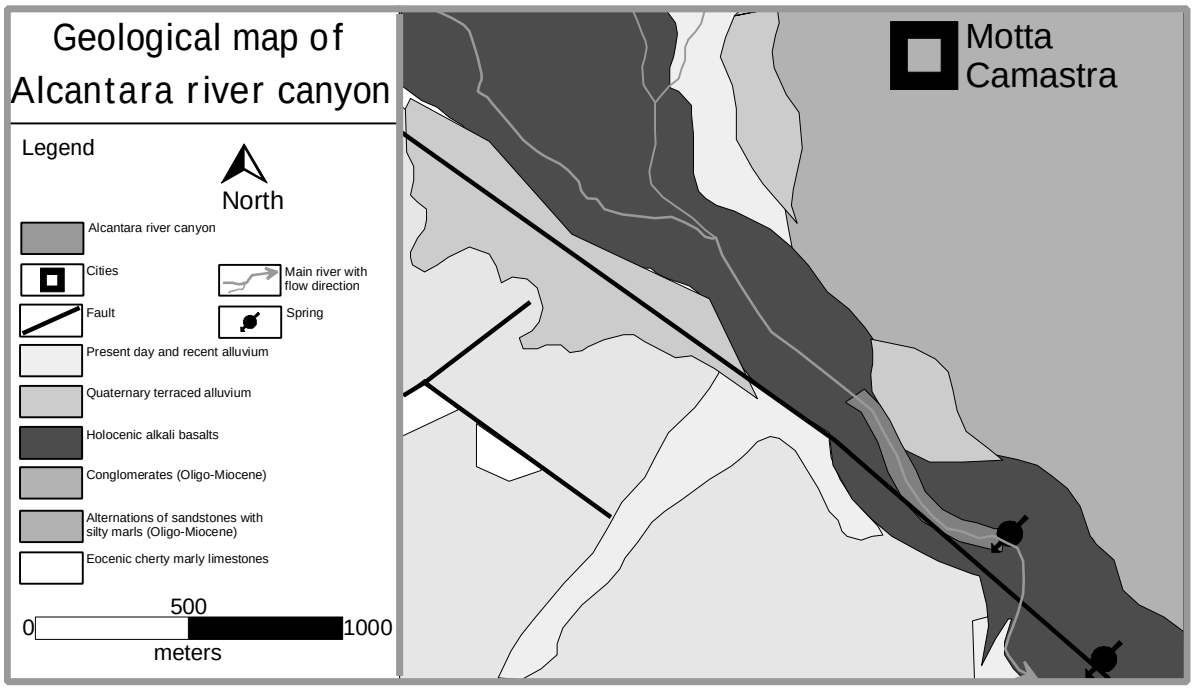

Fig. 4 - Geological map of Alcantara river canyon.

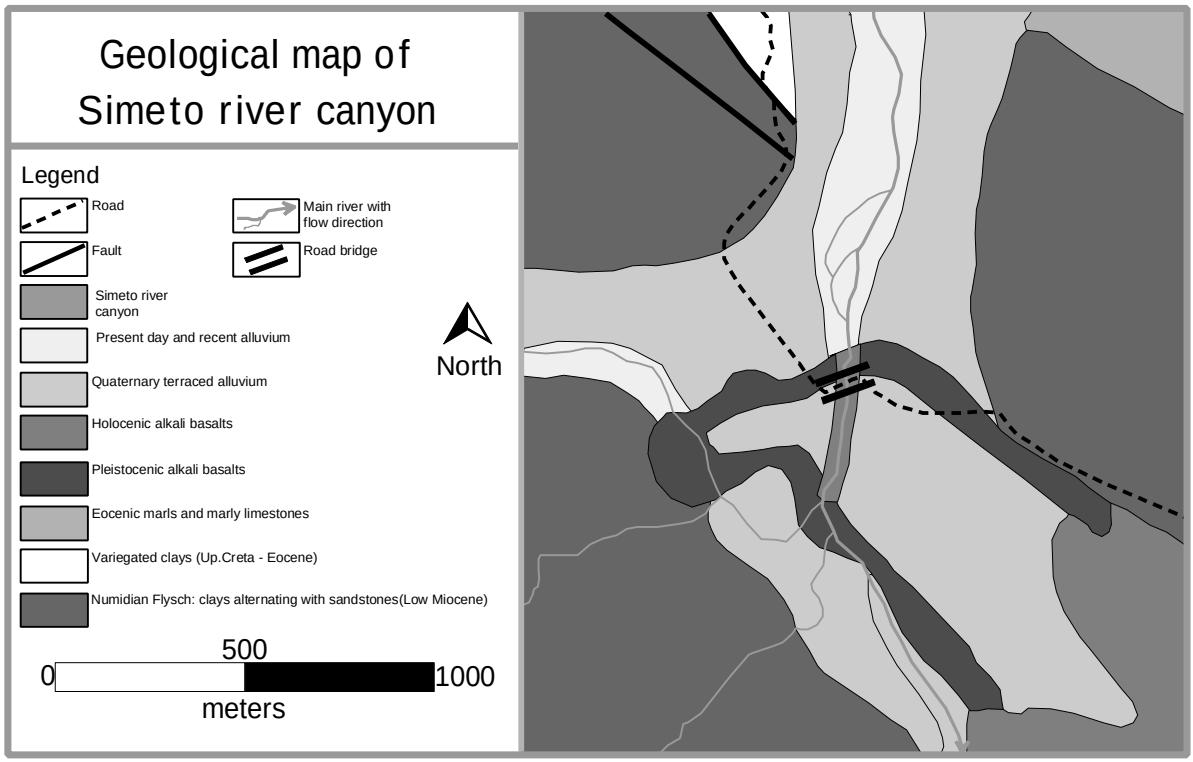

Fig. 5 - Geological map of Simeto river canyon.

Only when a peculiar characteristic of lavas, like the columnar fracturing, is present the morphological evolution of a basaltic canyon shows secondary features strictly related to its lithological nature.

We can then conclude that while the morphological evolution of lava caves is strictly related either to their lithological nature either to the very particular morphogenetic agent occurring in their formation (flow of the melted hosting rock itself), so that the resulting morphologies are to be considered as very particular karst forms, in the case of lava canyons we found features similar to other ones developed in fluvio-karst (Pollina river or Faguara creek, Madonie Mounts, Sicily)

or simply fluvial system (sandstone canyon of Vicaretto creek, Madonie Mounts), except same secondary features due to columnar fracturing.

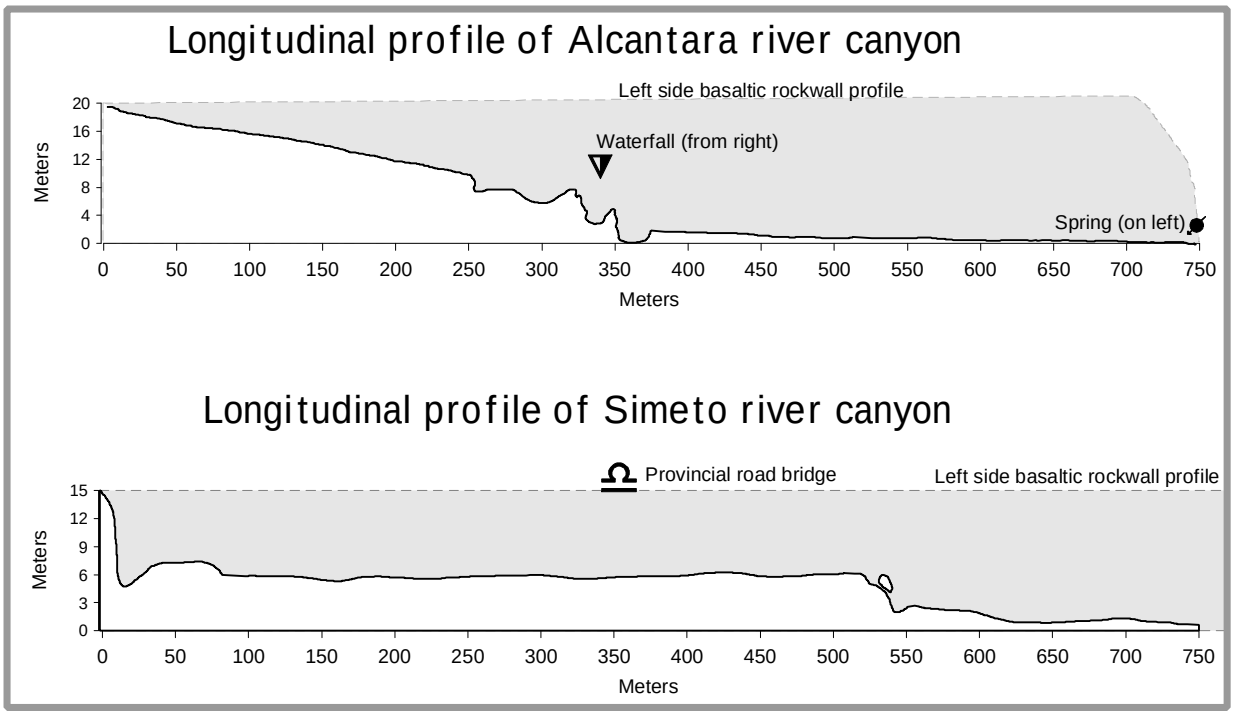

Fig. 6 - Longitudinal profiles of Alcantara and Simeto rivers canyons.

Water quality and environmental aspects

According to the sicilian legislation (regional law 14/88) governing the institution of protected areas, a transitory regime of restrictions in land use and environment protection norms is active since the insertion of the area in the Regional Plan of Parks and Natural Reserves (1991).
In particular, the Alcantara canyon is considered only of geological and geomorphological interest, the Simeto canyon has been proposed for the institution of a natural reserve for the protection of its peculiar riparial and limnic environments rich of botanical and fauna species.
Due to this different classification, only abiotic interesting components in the Alcantara canyon, very important biological aspects in the Simeto ecosystem, river water pollution control is expected to be more important in the latter area that in the former.
As showed by the data acquired during a field session conducted in August 1999 and presented in the graph of Fig.7, pollution presents dramatic level in the Simeto area despite its environmental interest.
Taking into account the italian laws about water pollution control, and in particular the D.P.R. 236/88, receipting an european community directive about maximum/minimum values of some chemical parameters in water destined to human consumption, it can be seen how in the Simeto area, except D.O. values, all the guide values, and in two cases the limit values too, are not respected in river waters.
In particular, high concentrations of nitrogen and phosphate ions are due to the wide agricultural use of chemical fertilizers in the land fields crossed by the river. Environmental pollution is augmented by the illegal discharge, from the road bridge crossing the canyon in its middle, of a big quantity of solid wastes and empty plastic tanks of pesticides and fertilizers (classified as dangerous wastes); the presence of empty tanks of a wide variety of chemical hazardous products on the river bed leads to the supposition that the same chemical species are present also in river waters, with a dramatic depletion of environmental quality of the protected ecosystem.

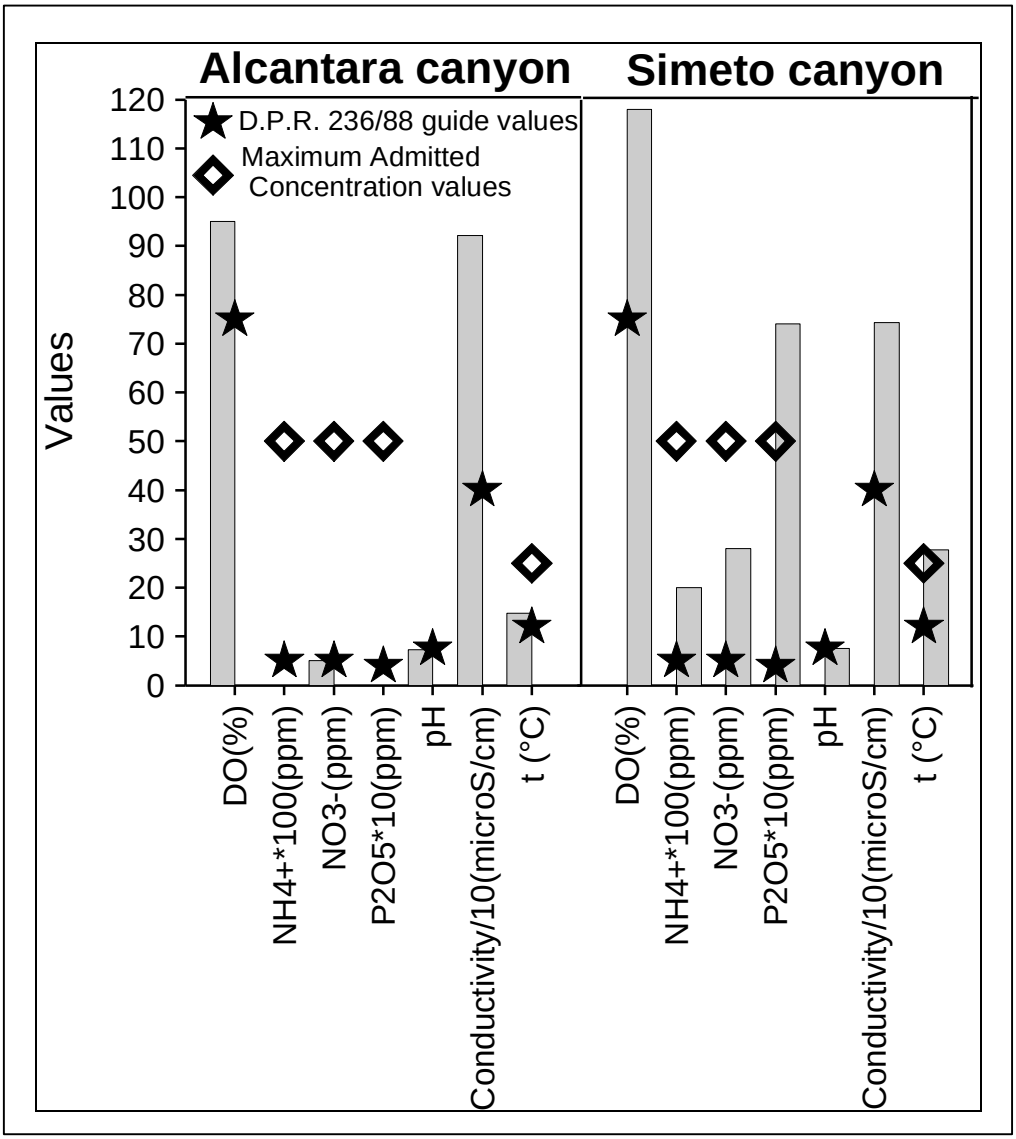

Fig. 7 - Chemical parameters of Alcantara and Simeto rivers surface waters.

As a paradox, except the visual perception of wastes, that represents on itself a negative environmental impact, the same pollution factors should cause a minor impact in the Alcantara river, where only an abiotic ecosystem is protected, but where the mitigation interventions on wastewaters discharged into the river (water purification plants treating sewer effluents of the cities located upflow the canyon) have lowered water pollution down to a reasonably low level compatible with the presence of a protected area of geological interest

Conclusions

The two studied canyons present very different characteristics, either from the hydrological either from the geomorphological points of view.
In particular, the observation of the morphological characteristics of these features leads to the conclusion that, while the morphological evolution of lava caves is strictly related either to their lithological nature either to the very particular morphogenetic agent occurring in their formation , in the case of lava canyons we found features similar to other ones developed in fluvio-karst or simply fluvial system, except same secondary features due to columnar fracturing.

Both the Alcantara and Simeto canyons, due to their environmental characteristics, have been comprised in the Regional Plan for Parks and Natural Reserves of the Sicilian Region (1991) as natural reserves to be instituted in the near future.
Surface water quality, as a result of a first field sampling session, seems to be in the case of Simeto river not compatible with the presence of a natural reserve of biotic interest.

Bibliography

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