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LITTLE ICE AGE IN THE TARANTO AREA (APULIA, SOUTHERN ITALY)

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ABSTRACT: Rossi C.A., Canora F. & Spilotro G., *Little Ice Age in the Taranto area.* (IT ISSN 0349-3356, 2011)
The present study focuses on the key role that the interactions of the sea level changes and hydrogeological mechanisms played on the evolution of the interconnected dynamics of the actual geomorphological and hydrogeological system of the Taranto area, from the Quaternary glacial age to the last Little Ice Age.

RIASSUNTO: Rossi C.A., Canora F. & Spilotro G., *La Piccola Età Glaciale nell'area di Taranto (Puglia, Italia Meridionale).* (IT ISSN 0349-3356, 2011)
*Il presente studio è relativo al ruolo chiave che le interazioni tra le variazioni del livello del mare e i meccanismi idrogeologici hanno avuto sull'evoluzione delle dinamiche interconnesse dell'attuale sistema geomorfologico ed idrogeologico nell'area di Taranto, dall'Età Glaciale del Quate*rnario fino alla Piccola Età Glaciale.

Key words: sea level changes, Little Ice Age, Taranto area (Apulia)

Parole chiave: variazioni del livello del mare, Piccola Età Glaciale, area di Taranto (Puglia)

In the Murgia region (Apulia, southern Italy) Quaternary sea level stands and variations with consequent setting of the base level of karst groundwater, played a key role in the evolution of the inland and coastal morphology (CANORA *et al*., 2010), particularly in the Taranto area.

This area is located on the border between two important geological structures: at NE by the Murgian Foreland and in the W side by the Bradanic Foredeep. It is characterized by a powerful Cretaceous limestone and dolomite bedrock, on which are deposited clastic regressive formations.

The recognized stratigraphic sequence is represented by the Altamura Limestone (Cretaceous sup.), the Gravina Calcarenites (Pleistocene inf.), the sub-Apennines Clays Formation (Pleistocene inf.), the Unity of Monte Castiglione Calcarenites (Calabrian-Tyrrenian), the terraced marine deposits, as well as continental marsh deposits, recent sand beach deposits and continental eluvio-colluvial and alluvial deposits.

The geomorphology of the area is represented by a series of Pleistocene terraces that descend to the sea, placed at various altitudes, related to the sea and land variations. These terraces more recent as you approach the sea, are bordered by abrasion sea cliffs, corresponding to successive shorelines almost parallel to the current one.

The submerged area of the Taranto Gulf is formed by a morphologically very troubled southern sector because of the continuation of the Apennines, and by the northern sector more flat and uniform typical of the Murgian Foreland area. The two areas are separated by a deep submarine canyon, Taranto Channel, which is set along the tectonic lines with Apennine trending. From a tectonic point of view the northern part of the study area is characterized by normal faults with regional trending NW-SE, while in the southern sector prevail oblique faults with trending EW (PIERI *et al*., 1997; FESTA, 2003; SPALLUTO *et al*., 2007).

The groundwater in the Murgia area is held in a huge aquifer within the Mesozoic fractured and karstified bedrock, floating on the sea water, with potential equal to zero where the boundary coincides with the coastline, and variable potential from few tens of meters to zero, on the border with the impermeable deposits of the Bradanic Foredeep.

This impermeable boundary along the W edge of the Murgia forces the flow direction towards the Taranto area, where the impermeable plugging disappears or tapers in thickness easily siphoned.

The average annual recharge of the entire Murgian hydrogeological structure was evaluated in 1000 Mm^3, while the groundwater flow towards the Ionian Sea is estimated at about 380 Mm^3 (DE GIROLAMO *et al*., 2002), corresponding to an outflow of the coastal and submarine springs, whose total actual discharge is about 15 m^3/s.

Most part of the aquifer drainage is present, because of the hydro-geo-structural conditions, in the Taranto coastal area, with typical important morphological evidences.

In particular, the drainage occurs by submarine springs in large erosive basins (the Mar Piccolo and Mar Grande), or through coastal springs, with large swamp areas (Tara, Springs as much as 4 m^3/s), or with short channel connection with the sea (the famous historical Galeso Spring).

The deep aquifer has resulted in numerous springs at the edge of the clay cover, both when the hydraulic head was higher than the topographic elevation of the impermeable threshold, and when the springs, due to the siphoning phenomenon of cover clay, came forward on the land and on the sea, forming the typical submarine springs, known as "Citri" or "Chidri", in the Mar Piccolo and Mar Grande (S. Cataldo Ring in the Mar Grande, Galeso Citro, S. Marco Citro, Cupizze Citro, Copre Citro in the Mar Piccolo), some of these have the discharge of about 1000 l/s.

When the thickness of the clay sediments is thin, or when the clays are fissured, the karst groundwater come out from the clay coverage, resulting in sub-aerial springs, whose evolution, a constant sea level, is determined by the relative elevation of the top of the limestone in that point, respect to sea level.

In addition to the important aquifer contained in the fractured and karstified carbonate, modest aquifer are located at the contact between the marine sand or calcarenites of the Tyrrhenian terraces and the blue clays.

The emergence points of the karst aquifer changed with changes in sea level, resulting in correspondence of the stands, with typical forms similar to those actually active, but which have undergone total or partial fossilization.

The discriminating condition stems from the position of the new sea level, respect to the bottom of the basin associated with the siphoning of the groundwater, partially filled by swamp deposits. If the new sea level, is higher than that elevation, part of the sea water enter in the basins, because of the high evapotranspiration.

This mechanism has led to the formation of Saline Taranto (SPILOTRO & LOCARDO, 1993), that correspond to pronounced elliptical flat basins around the ancient karst groundwater emergencies.

The sensitive balance of these unique geological morfostrutture makes them the perfect climate indicators, because the reduction of evapotranspiration and the increase of precipitation brings back their swamps, with reversal of water flow towards the sea.

The Quaternary paleoclimatic evolution has seen a succession of interglacial phases which led to remarkable changes in sea level.

The Holocene is presented as a post-glacial phase outlining a period of strong heating (up to 9/7 Ka B.P.), followed by a slow but gradual cooling. Within this trend there are many hot/cold oscillations, in which, at the mid-latitudes, those extraordinary appear to affect the cold period of the Little Ice Age (conventionally defined as the period between about 1600 and 1850) and actual heating (SILENZI & ANTONIOLI, 2000).

Among several recent cycles, the Little Ice Age seems to be confirmed in the Taranto area by the analysis of the many documents, old maps and historical documents of the period between 1567 and 1850, that clearly indicate the evidence of new climate conditions, which highlighted the recent morphological evolution, explicitly related to the sea level changes during the Little Ice Age, in which there was a prolonged cooling climate by about 1 °C, where the climate changed in a more humid conditions (SPILOTRO & ROCCANOVA, 1990).

In particular, this analysis shows a historic evolution of those basins correspondent to the saline, which are not too deep.

In the maps dating from 1567 to 1585, these basins appear well developed and connected to the sea. In the next maps, dated 1620 and 1692, they disappear and reappear, finally, in the maps of 1771 and 1810.

The rebirth of the saline in the last period, as well documented in wide historical literature, caused the beginning of a difficult period, with a high mortality rate, due to climatic situations characterized by a remarkable raise in humidity, with the relative swamping of the area, as well shown in the more recent maps.

In conclusion, small variations of the sea level and more noticeable rainfall variations have caused the swamping of wide endorheic areas, internal, nowadays, in Taranto urban context, perimetral in the past, and, consequently, awful health conditions.

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