

## Sinkhole phenomena at San Basile, Northern Calabria

S. SURIANO (1), M. PARISE (2), T. CALOIERO (3), G. LANZA (4), G. IOVINE (5)

Key words: *sinkhole, origin, morho-evolution, Calabria.*

### INTRODUCTION

Within the framework of a regional study, recently performed to implement a data base of the sinkholes in plain areas in Calabria (IOVINE & PARISE, 2008), n.5 cases have been recognised in the territory of San Basile (Northern Calabria) at “Piano dell’Acqua”. The sinkholes are located in a hilly setting, in which the main landform is a slight valley draining toward the east (Fig.1). The area is characterized by Pliocene conglomerate and sand, likely dislocated by tectonic lines (CASMEZ, 1969; 1970).

The sinkholes show a variable freshness appearance (Fig.2). They are limited in size, with maximum diameter of 10 m, and maximum depth of 2.5 m; two of them are elongated, whilst the remaining three are circular (Tab.1).

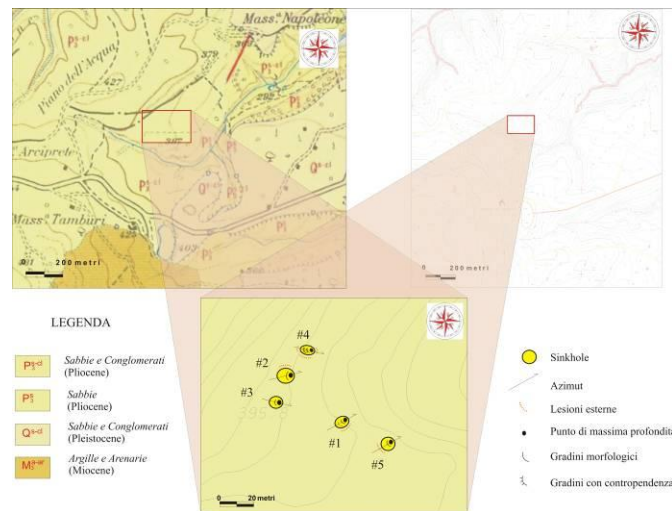


Fig. 1 – Litological-structural characteristics of Piano dell’Acqua.

#	L	$\alpha$	$\beta$	$\gamma$	W	A	D
1	9.04	N60°E	8.0°	1.5°	5.30	40	<b>2.5</b>
2	9.80	N75°E	12.5°	6.0°	<b>8.00</b>	<b>62</b>	<b>2.5</b>
3	5.20	N100°E	<i>2.0°</i>	<b>13.0°</b>	<i>5.15</i>	<i>21</i>	<i>1.5</i>
4	8.79	N100°E	<b>14.5°</b>	<i>1.0°</i>	5.51	40	1.6
5	6.01	N60°E	10.5°	3.0°	6.00	28	<b>2.5</b>

Tab. 1 – Main characteristics of the Piano dell’Acqua sinkholes. For each sinkhole are given: id. (#); major axis length (L), azimuth ( $\alpha$ ) and inclination ( $\beta$ ); minor axis length (W) and inclination ( $\gamma$ ); area (A), depth (D) of the most depressed portion in relation to the most elevated part of the rim. For each column, maximum values are given in bold on a pink background; minimum values are in Italics on a grey background.

### METHOD

The sinkholes were initially examined by means of multi-temporal aerial photos. The outcomes from this analysis were checked in the field through geological, structural and geomorphological surveys.

A historical analysis was also performed to collect and critically evaluate the existing information and testimonies about age of occurrence of the phenomena. At this aim, several interviews with local inhabitants were performed, and a number of archives scrutinized.

Geophysical investigations have also been carried out (cf. profiles in Fig.3) to investigate the geo-lithologic and hydraulic setting of the area. The resistivity of the terrain has been evaluated through bi-dimensional models (ERT, Electrical Resistivity Tomography – GRIFFITHS *et al.*, 1990; 1993).

By analysing historical, geomorphologic, hydrological and geophysical evidence, preliminary considerations of the origin and evolution of the sinkholes in the study area (Fig.4) are presented.

### PRELIMINARY RESULTS

The study allowed to hypothesize that two sinkholes developed during the winter 2000-2001, with likely rapid formation. Two other cases probably originated during the 70’s, as also suggested by the age of the vegetation hosted within the

- (1) Geologist, Belmonte (CS) Italia.  
 (2) CNR-IRPI – U.O.S. di Bari, Italia.  
 (3) CNR-ISAFOM – U.O.S. di Rende (CS) Italia.  
 (4) Geologist, Castrovillari (CS) Italia.  
 (5) CNR-IRPI – U.O.S. di Cosenza, via Cavour 6 – 87036 Rende (CS) Italia - e-mail: g.iovine@irpi.cnr.it

sinkholes. The last sinkhole, eventually, opened sometime between February 2001 and November 2007. According to the collected testimonies, a further phase of sinkhole development might have occurred in the first half of the past Century, but no field evidence of this older phase has been found so far (IOVINE *et al.*, 2010a, b).

Furthermore, analysis of the seismic catalogues showed that



Fig. 2 – Geomorphologic evidence of the sinkholes #2 (top) and #4 (bottom).

no earthquake can be identified as possible trigger of any of the sinkholes at Piano dell'Acqua. Therefore, the origin of the studied phenomena should be related to sub-cutaneous erosion, within an area that is rich in groundwater (as also shown by the site name, meaning “Water Plain”).

Local changes in the water table, both related to climate and man-induced activities, may have triggered the development of the sinkholes. These can be classified – according to the first results of the tomography which suggest not cohesive deposits for the surface materials - as belonging to the “dropout” types (cf. classification suggested by WALTHAM *et al.*, 2005).

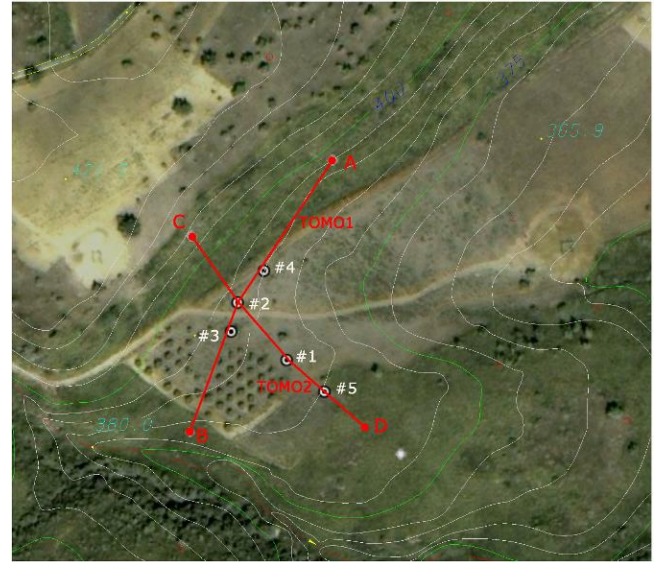


Fig. 3 – Traces of the tomography (Tomo-1 and Tomo-2) performed at Piano dell'Acqua. Locations of sinkholes (#1-5) are also shown.

In this study, the most recent results of the performed investigations, together with evidence of field surveys are discussed.

## REFERENCES

- CASMEZ (1969) - *Foglio 221-II-NW della Carta d'Italia 1:25.000 dell'I.G.M. "Castrovillari"*. Carta Geologica della Calabria. Cassa per Opere Straordinarie di Pubblico Interesse nell'Italia Meridionale. Poligrafica e Cartevalori, Ercolano.
- CASMEZ (1970) - *Foglio 221-III-NE della Carta d'Italia 1:25.000 dell'I.G.M. "Saracena"*. Carta Geologica della Calabria. Cassa per Opere Straordinarie di Pubblico Interesse nell'Italia Meridionale. Poligrafica e Cartevalori, Ercolano.
- GRIFFITHS D.H. & BAKER R.D. (1993) - *Two-dimensional resistivity imaging and modelling in areas of complex geology*. Journal of Applied Geophysics, **29**, 211-226.
- GRIFFITHS D.H., TURNBULL J. & OLAYINKA A.I. (1990) - *Two-dimensional resistivity mapping with a computer-controlled array*. First Break, **8**, 121-129.
- IOVINE G. & PARISE M. (2008) - *I sinkholes in Calabria*. In: Nisio S. (Ed.), *I fenomeni naturali di sinkhole nelle aree di pianura italiane*. Mem. Descr. della Carta Geol. d'It., **85**, 323-386.
- IOVINE G., PARISE M., CALOIERO T., LANZA G. & SURIANO S. (2010 a) - *I sinkhole di Piano dell'Acqua (San Basile – Calabria settentrionale). Indagine sulle fasi di attivazione su base storica, geomorfologica, ed idrologica*. In Nisio S. (Ed.), *Atti del 2° Workshop internazionale "I sinkholes - Gli sprofondamenti catastrofici nell'ambiente naturale ed in quello*



Fig. 4 – Panoramic view of the Piano dell'Acqua area.

antropizzato”, Roma 3-4 dicembre 2009-Auditorium ISPRA, Tipolitografia CSR, Roma, 565-581.  
IOVINE G., PARISE M., FERRARO G., LANZA G. & SURIANO S. (2010 b) - *Primi risultati di prospezioni di tomografia geoelettrica a Piano dell'Acqua (San Basile – Calabria settentrionale)*. In Nisio S. (Ed.), Atti del 2° Workshop internazionale “I sinkholes - Gli sprofondamenti catastrofici

nell'ambiente naturale ed in quello antropizzato”, Roma 3-4 dicembre 2009-Auditorium ISPRA, Tipolitografia CSR, Roma, 979-990.  
WALTHAM T., BELL F. & CULSHAW M. (2005) - *Sinkholes and subsidence: karst and cavernous rocks in engineering and construction*. Springer, 382 pp.