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Short Communication

The relevance of the 1198 eruption of Solfatara in the Phlegraean Fields (Campi Flegrei) as revealed by medieval manuscripts and historical sources

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ABSTRACT

The Phlegraean Fields (Campi Flegrei) caldera in Italy had one well-documented eruption during the historical period (1538). Another eruption at Solfatara in 1198 is reported by sixteenth and seventeenth-century scholars, and has been commonly regarded as uncertain. In this paper we first discuss the circumstantial evidence and report of this eruption, then discuss the relevance of drawings made in the thirteenth through the fifteenth century illustrating the Solfatara and the primary literary and historical sources describing the site. We infer that the eruption was at most a minor phreatic explosion and we explore the conditions that may have led to the occurrence of this event and the establishment of a small crater pool subsequently used as a thermal bath from the later Middle Ages onward.

1. Introduction

The Phlegraean Fields (Campi Flegrei) constitute an active caldera whose activity spans the last 50,000 yr (Rosi and Sbrana, 1987; Lirer et al., 1987; Scandone et al., 1991). The caldera had at least two major caldera forming events: the Campanian Ignimbrite (CI) eruption at 39,000 yr BP and the Neapolitan Yellow Tuff (NYT) eruption at 15,000 yr BP (Lirer et al., 1987; De Vivo et al., 2001; Deino et al., 2004) which formed a complex caldera structure. After such events, intracaldera activity occurred episodically along the border of the caldera, mainly between 15–12,000 yr and 8000 yr BP, and between 4800 and 3700 yr BP (Rosi and Sbrana, 1987; Di Vito et al., 1999). During the historical period, there are reports of only two eruptions at Solfatara in 1198 (considered as uncertain) and in 1538 AD with the formation of a new scoria cone called Monte Nuovo. The eruption of 1538 was preceded by a period of slow ground inflation lasting for many years (Parascandola, 1947; Dvorak and Mastrolorenzo, 1990), and a rapid inflation in the two days preceding the eruption (Parascandola, 1946).

Slow ground movement has affected the caldera floor since long time, as recognized after the excavation, in the first half of the eighteenth century, of the ruins of an ancient Roman market, the "Serapeum" (*Macellum*), in the city of Pozzuoli (Parascandola, 1947). The Serapeum preserves three high standing columns with evidence of a marine submersion provided by the holes of lithodomes which reached a level of 10.26 m above Roman sea level. Charles Lyell, in his "Principles of Geology", firstly interpreted the phenomenon of Pozzuoli as due to the submersion and subsequent emersion of the ground (Lyell, 1837). Regular measures of geodetic benchmarks in the Phlegraean Fields began in 1905, with precision geometric levelings, using a reference benchmark in the city of Naples, outside the caldera borders. The levelings repeated in 1907, 1922, and 1953 confirmed the slow subsidence of the ground with the maximum subsidence rate of about 1 cm/yr located in the center of the caldera near the city of Pozzuoli and a regular decrease toward the edges of the caldera (Di Giesi, 1954; Lirer et al., 1987).

2. The "eruption of Solfatara of 1198"

The last period of intense volcanic activity of the Phlegraean Fields occurred between 4.8 and 3.8 kyr BP (Rosi and Sbrana, 1987; Di Vito et al., 1999). The volcano of Solfatara (Fig. 1) was formed during one of the last eruption of this period between 4.1 and 3.8 kyr BP (Di Vito et al., 1999). After 3.8 kyr BP, a long period of quiescence lasted until 1538 when the eruption of Monte Nuovo occurred. The fumarolic state of Solfatara is reported during roman time by Strabo (63/64 BCE–24 CE). Translated from the Greek, the passage reads, "above the city (Pozzuoli) lies the Forum of Hephaestus (the roman name of Solfatara), a plain shut in all round by exceedingly hot ridges, which in numerous places have fumaroles that are like chimneys and that have a rather noisome smell; and the plain is full of drifted sulphur".

The first known written testimony of an eruption of Solfatara was given by Scipione Mazzella in 1591. No reference provides the source of the information, however. Mazzella states (in translation),"In the year 1198, when Frederick was ruling, Solfatara ejected a great fire with large clusters of stones, which damaged all the village (Pozzuoli), and at the same time there was an earthquake felt from each building and everything trembled and was damaged". A similar description is

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Fig. 1. Oblique aerial view of the Solfatara Crater. In the center are visible the remains of the mud pool that covered a larger area until 1970.

offered by a coeval author, Giulio Cesare Capaccio, in 1604. All subsequent authors make reference to these two sources; therefore, their testimonies cannot be taken as an independent evidence of the eruption. Previous authors of the history of Pozzuoli or those which described the eruption of Monte Nuovo in 1538 (e.g. Loffredo, Marchesino, Delli Falconi, Porzio, Del Nero, as reported in Parascandola, 1946) do not make any reference to eruptions of Solfatara.

The lack of a deposit clearly referable to this eruption added uncertainty to the real existence of this event, or to its nature (Vecchio et al., 1995).

Since Roman times, the Phlegraean Fields suffered an economic decline both because of barbarian invasions (the city of Pozzuoli was destroyed by Totila in 545 AD) and because of the slow sinking of the ground that caused the submersion below sea level of the coastal suburbs. Several sources of the eighth, tenth, and twelfth centuries report a submersion of part of Pozzuoli (Fredericksen, 1977; Toaff, 1965). However, the area remained known for its thermal springs. Very popular during the Roman period the thermal baths of Baia, in particular, were mentioned by Ovide, Horace, Propertius, Seneca, et al. and their fame remained unchanged during the early Middle Ages. St Gregory the Great (540–604 CE) reputedly mentions the thermal springs of Agnano (close by the Solfatara) in his *Dialogues* (1, 4), while references to the thermal springs of Baia are also made in manuscripts of the tenth and twelfth centuries (Toaff, 1965). Throughout the Middle Ages, moreover, the thermal baths were regarded as the most efficient and cheap cure for many diseases, and the Phlegraean Fields came to be well known for the richness of its many different springs that could be used by anyone.

The most famous account of the merits of these baths remains the Latin poem written by the court poet Peter of Eboli around 1200 for either Henry VI or Frederick II, though Peter was only recognized as the author of the poem in the 1800s. Entitled *Liber Balneorum Terrae Laboris*, also known as *Balneis Puteolanis*, the poem, which continued to be expanded, describes at its greatest length thirty five thermo-mineral baths between Naples and Baia, and illustrates the diseases cured by each by accompanying miniatures. Of the numerous copies of the manuscript recording the popular poem, only twenty eight, made at different times, still survive (Kauffmann, 1959; D'Amato, 1976; Yegul, 1996). Thirteen of these manuscripts are illustrated by artists, primarily Neapolitan, depicting the baths and the nearby environment. The oldest surviving manuscript, dated around the third quarter of the thirteenth century is held by the Biblioteca Angelica (Angelica ms 1474), and preserves an illustration of Balneum Sulfatara.

Relying on this manuscript, Di Bonito and Giamminelli (1992) claim evidence of the eruption of Solfatara of 1198 based on the illustration (Fig. 2) of the bath called "Bulla", on the eastern flank of the crater of Solfatara, in the locality presently called "Pisciarelli", which shows flames coming out of a hill where Solfatara is located.

Later manuscripts, containing illustrations of the same bath (e.g. Bodmer and Valencia manuscripts), do not show flames coming out of Solfatara. The most reliable depiction of the volcano seems to be that found in a fifteenth-century copy of the poem in Edinburgh (Edinburgh, Ms. 176 (Laing 181)); (Fig. 3) illustrating another bath (Subvenit Homini) located along the coast of Pozzuoli. The illustration shows Solfatara in the background emitting thick fumes which might suggest the eruption of Solfatara or more likely a continuation or even a strong increase of its fumarolic activity. Apart from the style of its illustrations, a confirmation of the fifteenth-century dating of the Edinburgh copy is evidenced by the illustration of the bath called Cantarellus (Fig. 4A). This bath was close to the Serapeum and shows