of carbon in Isua's rocks, claimed initially to be of biological origin because of its light isotopic composition (Schidlowski 1988). This isotopic fractionation may also be the consequence of hot fluids reacting with older crustal rocks (metasomatism), however (van Zuilen et al. 2002). The second concerns the nature of the "earliest microfossils" (3.4–3.5 Ga) described by Schopf and coworkers in the Australian Warrawoona and Apex Formations as cyanobacteria (Schopf and Packer 1987; Schopf 1993), which have been later reinterpreted as possible artifacts (Brasier et al. 2002). The origin of usually microbially derived minerals, such as magnetite (Schuler and Frankel 1999), has also been put into question (Buseck et al. 2001; Treiman 2003; Weiss et al. 2004). Organic fossilized biomarkers, such as fossil lipids (e.g., hopanes, steranes) are certainly biogenic, but these are not exempt of contamination problems. To overcome all these difficulties, the identification of nonambiguous traces of ancient microbial activity will most likely demand the combination of several concurrent biosignatures. In this sense, the study of contemporary model system analogous to past environments is essential to understand the fossilization process and correlate present-day biosignatures with old putative biogenic traces.

Various recent models on the origin of life propose that it originated some time between 4 and 3.7 Ga ago in moderately hot to hot environments, possibly linked to hydrothermal fluid activity (Kasting and Ackerman 1986; Wächtershäusser 1988; Nisbet and Sleep 2001; Martin and Russell 2003). Modern hydrothermal biotopes colonized by thermophilic and hyperthermophilic microorganisms constitute therefore potential model systems to identify biosignatures and link them to a particular microbial diversity and activity. Among the earliest studied contemporary geothermal areas, together with Yellowstone in the U.S., is the Solfatara Crater close to Naples, Italy (Figure 1), where the thermoacidophilic archaea *Sulfolobus solfataricus* and *S. brierleyi* were first isolated (DeRosa et al. 1974, 1975; Zillig et al. 1980). Later, other hyperthermophilic archaea belonging to the genera *Acidianus, Pyrobaculum* and *Metallosphaera* have been isolated from Solfatara as well (Huber et al. 2000a, 2000b). The Solfatara Crater, characterized by its subareal activity, is located in the Mid–Eastern part of the Campi Phlegrei Caldera, which is a nested, 12-km wide structure, formed by two main collapses corresponding to Campanian Ignimbrite and Neapolitan Yellow Tuff eruptions (37,000 and 12,000 years ago, respectively) (Rosi and Sbrana 1987). Early studies revealed a major upheaval of the mantle beneath the area (Ferrucci et al. 1989). The top of the Campi Phlegrei Caldera magma chamber lies at 5 km depth, probably within carbonate sequences (Rosi and Sbrana 1987). Volcanological, petrological and geophysical data suggest that the activity at Campi Phlegrei Caldera was once fed by a large magmatic reservoir (Panichi and Volpi 1999). Solfatara's volcanism belongs to the last volcanic epoch of the Campi Phlegrei Caldera. In past times, both explosive and effusive eruptions occurred within short-time intervals, but extensive explosive volcanism finished ~4,000 years before present. Today, the Solfatara activity is marked by continuous hydrothermal emissions within mud pools in the central sector of the crater and fumarolic activity in the Northern side, possibly fed by a 1.5-km deep, low-permeability, geothermal aquifer of mixed magmatic-meteoric origin (Chioni et al. 1984). The geothermal system is vapor dominated, and temperatures range from very high (the hottest fumaroles ~160°C; Tedesco et al. 1988) to moderate (40–50°C for areas around emission points). The pH of

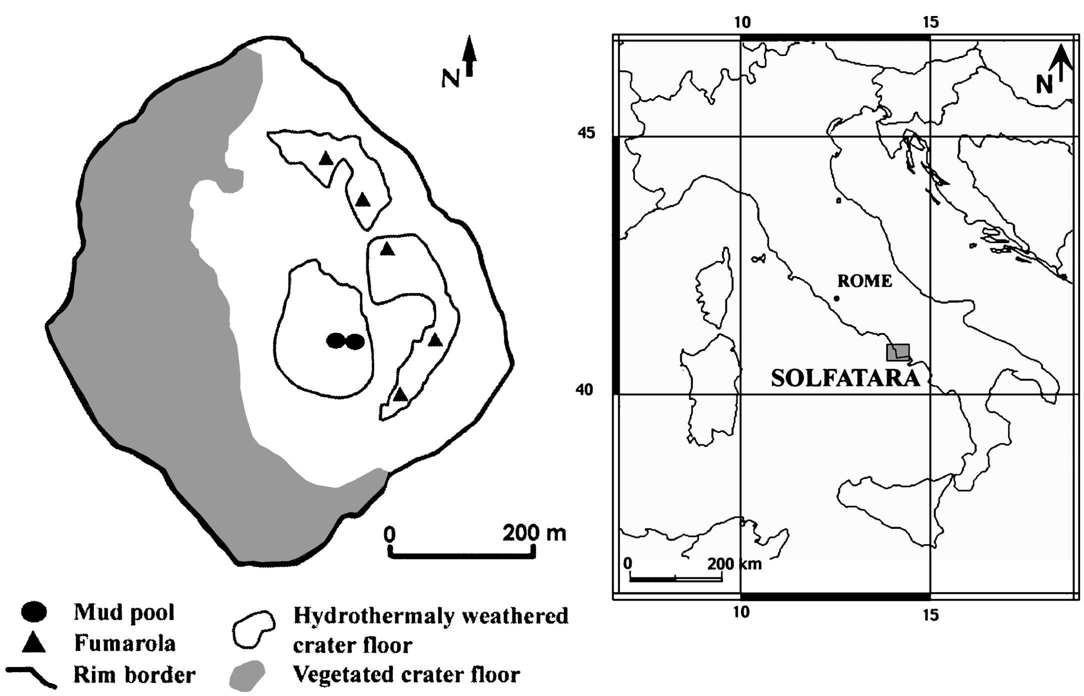

Figure 1. Location of Solfatara Crater and sampling sites.