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"Fast Exhumation of a Magmatic-Hydrothermal System in a Resurgent Caldera Environment"

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Fast Exhumation of a Magmatic-Hydrothermal System in a Resurgent Caldera Environment

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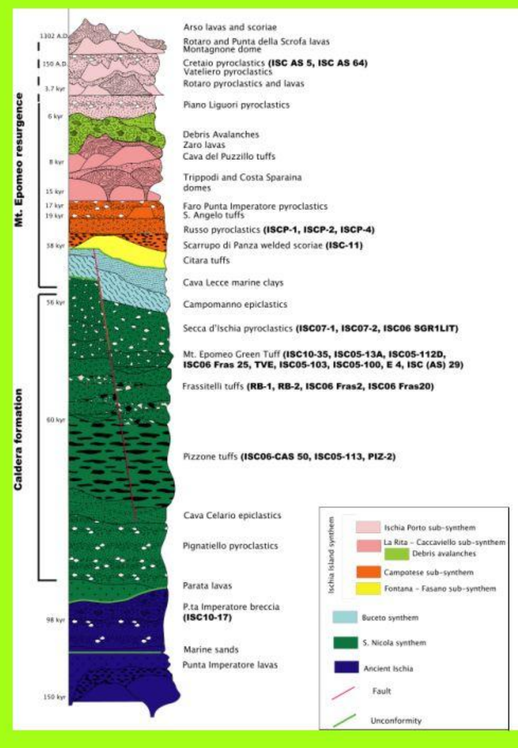
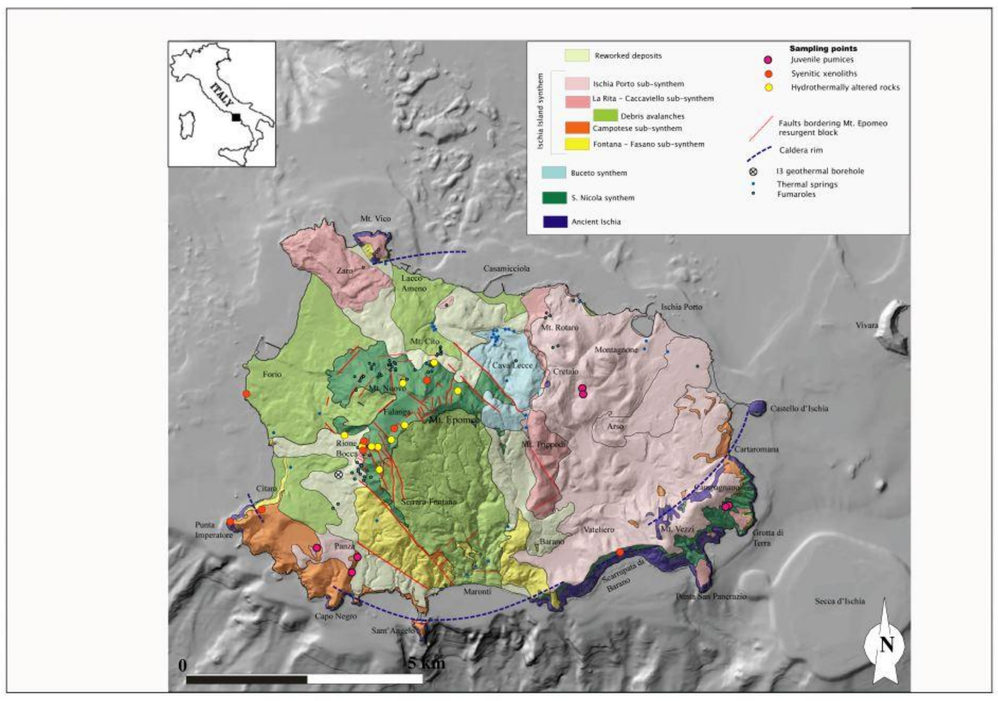
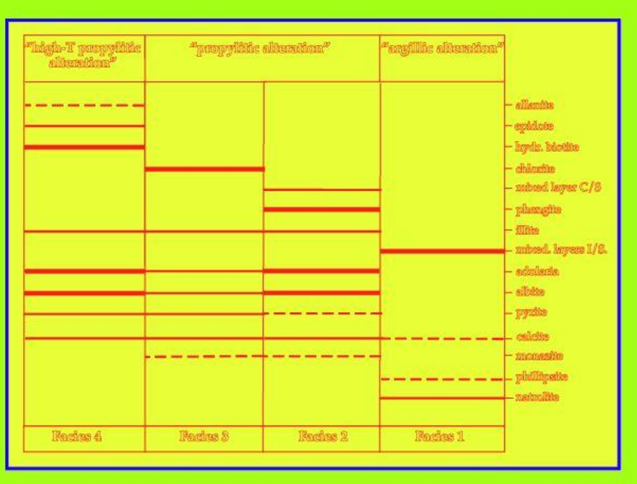
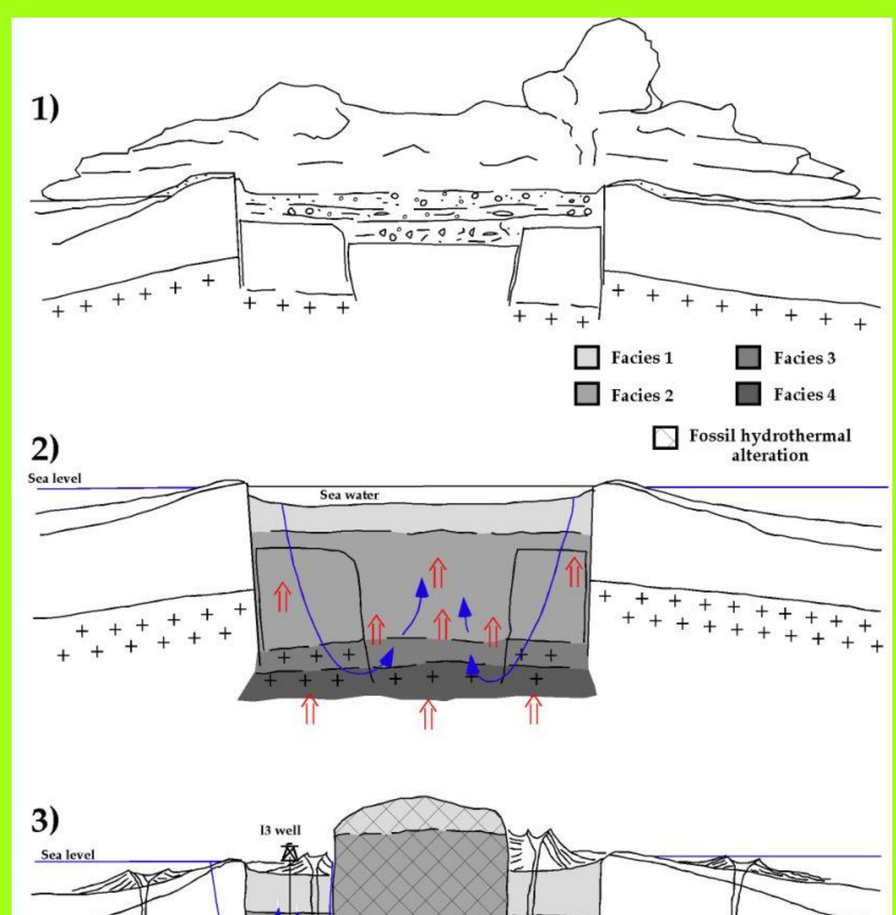
Ischia island is located in the northern part of the Gulf of Naples, Italy. Together with Campi Flegrei and Mt. Vesuvius, this region constitutes an important Quaternary volcanic field in th e Mediterranean. Ischia represents a rare case of well-exposed, young, and ongoing caldera resurgence associated with uplift of the intra-caldera rocks. Resurgence is a common feature in large calderas, with pressurisation of the magmatic system and inflation of the magma chamber generally being considered as the mechanism for the doming of the caldera floor. Caldera depressions typically host active high-temperature geothermal systems, which are exploited for electrical energy production all around the world. Furthermore, caldera structures are often associated with epithermal precious and ba se metal mineralizations that represent the "fossil" equivalent of active geothermal systems. Ischia offers an unique opportunity to examine the three dimensional anatomy of a hydrothermal system, because of the exposure of up lifted rocks that form Mt Epomeo. The aim of this paper is to investigate the physical-chemical constraints on th e shallow magmatic reservoir and the related hydrothermal system beneath Ischia.

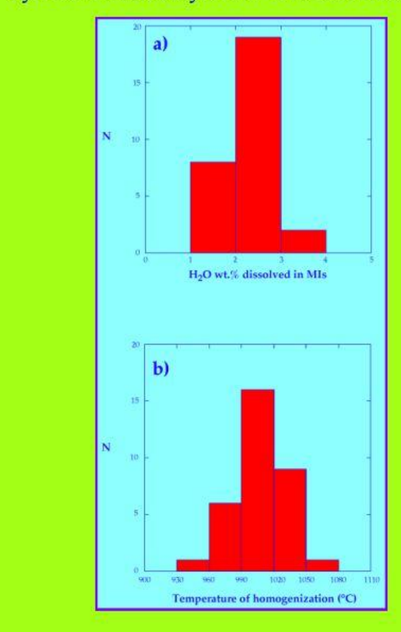


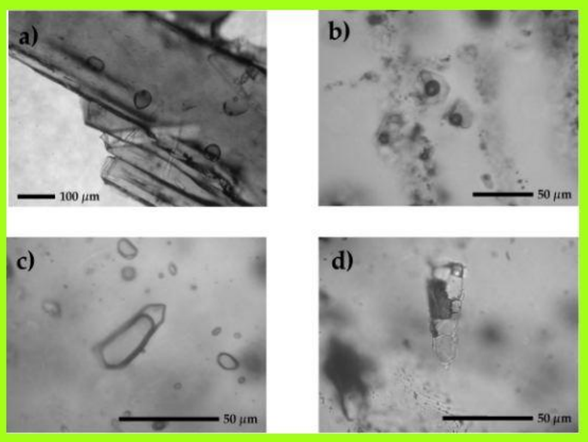




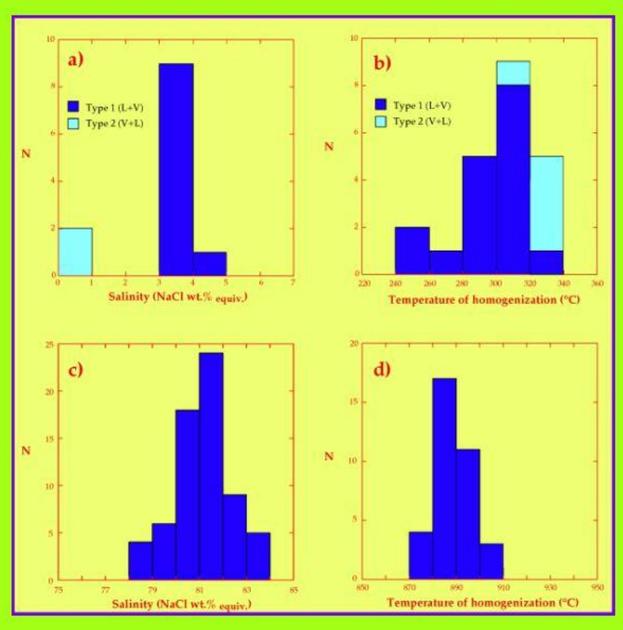


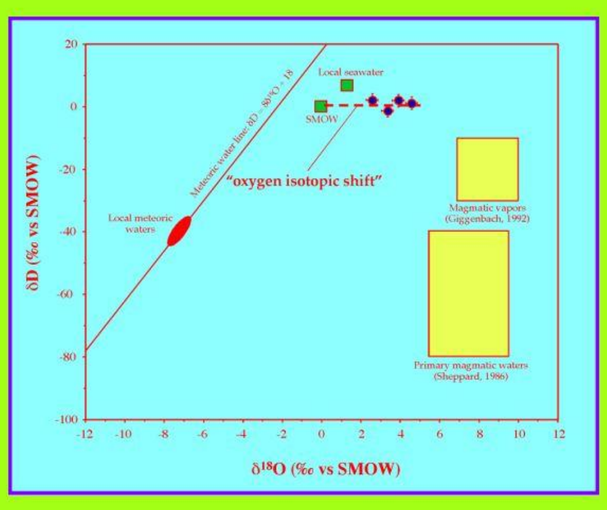
Schematic sequence summarizing the evolution of Ischia magmatic-hydrothermal system. A) Ca ldera filling eruptions; B) De velopment of seawater-dominated hydrothermal system inside the cauldron; heat energy was supplied by the shallow (~ 2km of depth) magmatic system; C) Resurgence and ex humation of part of the hydrothermal system, which remains active today in th e footwall sectors of the caldera. Red arrows = hydrothermal fluids; blue arrows = surficial waters.





Microphotographs of: a) two phase melt inclusions (juvenile fraction); b) two phase liquid rich fluid inclusions (hydrothermally altered syenitic xenoliths); c) two phase vapor rich fluid inclusion (hydrothermally altered syenitic xenoliths); d) Multiphase fluid inclusions (syenitic xenoliths). Note the bubble deformed by the occurrence of many daughter minerals.





The Ischia volcanic field experienced a major period of resurgence, following a series of large volume caldera forming eruptions between 73 and 56 ka, exposing a th ick pile of caldera-fill tuffs within an uplifted block that forms the present day Mt. Epomeo. Investigations of these uplifted ignimbrite deposits show that these rocks were subjected to strong hydrothermal alteration by fluids of marine origin. This allowed the development of a geothermal system with argillized units forming the impermeable cover of the system and underlying propylitized units that can be considered the geothermal reservoir. The rapid uplift of the Mt Epomeo block helped to preserve evidence of the high temperature geothermal system by preventing significant low temperature overprinting. We have clear evidence that fluids in the deepest part of the hydrothermal system penetrated the subvolcanic bodies present in the deeper parts of the island, to a depth of at least 1 km. The engine of the high-T hydrothermal system of Ischia can be identified as the shallow magmatic system, with a top at around 2 k m depth, that hosted hot (~ 1000°C) trachytic melts. This work fills a major gap in our understanding of the Ischia volcanic system and, more generally, offers an important contribution to the understanding of the magmatic-hydrothermal processes that occur inside resurgent caldera environments characterized by shallow and active magmatic systems.