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CHAPTER 5
The Island of Capraia

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5.1 HISTORICAL PERSPECTIVE

It is probable that the name of the island derives from the etruscan «carpa» (stone), a word which comes from the archaic Greek «Kalpe» meaning sepulchral stone. Then, the island's name passed from the etruscan «isola pietrosa» (stone island) to the roman «Capra» (goat) from which comes «isola delle capre» (island of the goats) and therefore «Capraia». Human history of Capraia is similar to that of Elba Island even if there are not sure remnants. Surely the island was inhabited by the Etruscan and was under the roman empire and followed its collapse. The island's history can be recognized from the Middle Age and during the last centuries by its artistic patrimony. The fortress San Giorgio, solemn and majestic, dominates the village Capraia, but can not be visited anymore. The very core was built by the Pisans in the 12th century while the later fortifications were built by the Genoese and especially so the San Giorgio wharf. The charming Torre del Bagno, built on a cliff hanging over the sea, dates back to the 16th or 17th century and probably made up a way of escape connected to the inside of the San Giorgio Fortress. Torre del Porto, erected in 1510 next to a Franciscan building in order to work as a guard for the small bay and as a bastion to the San Giorgio Fortress. Above the portico it is possible to admire a bas-relief that depicts the Saint while defeating the dragon and an analogous work inside the church depicts the Annunciation. The Franciscan complex dates back to the 17th century and faces Punta del Fanale. In 1873, it became a penal settlement and therefore even the small church in Pisan baroque style was desecrated. The Palazzone is the island's largest building and was built in 1873 by the Savoia family who wanted to relieve the island's economy through a cigar-factory. Strolling about the island it is possible to run into the ruins of Torre della Regina, located on a peak with the same name, a withered stone construction that reminds a Sardinian nuraghe, Torre dello Zenobito on the southern top of the island and the charming church Santo Stefano Protomartire.

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5.2 GEOLOGY AND PETROGRAPHY

The island of Capraia is the westernmost of the seven islands that constitute the Tuscan Archipelago, the third in size after Elba and Giglio. It is situated to the north of the island of Elba and to the east of Capo Corso, much closer to the Capo than to the Continent. Capraia (Fig. 1) has an extension of about 20

Km^2 and an elliptic shape, with maximum elongation along the N-S direction. It is about 8.0 Km long from «Punta della Teglia» to «Punta dello Zenobito» and is 4.0 Km wide. The length of Capraia coasts is about 30 km. A chain of hills runs along the western side of the island: the eastern slope is smooth and gradual, whereas the western one falls abruptly into the sea. Such strong asymmetry is the result of the action of a set of N-S normal faults and of regional stresses which lowered the western part of the original volcano (Fig. 1). The geo-volcanological history of Capraia is related to that of the Sardinia-Corsica massif and its rotation, that led to the continental collision and the Apeninic orogenesis. The island resulted from the subsequent extension of the area after the collisional event and the development of many fractures along which magmatic activity occurred.

Capraia is entirely constituted by overlapping lava flows and scarce pyroclastic deposits with high-potassium (HK)-calc-alkaline affinity. A few lava flows having shoshonitic affinities are also present. The genesis of Capraia occurred during Upper Miocene-Pliocene over three different cycles, according to geochronological studies of Barberi *et al.* (1986) and Aldighieri *et al.* (1998). Barberi *et al.* (1986) distinguished three climaxes of magmatic activity at 6.9 Ma, 4.5 Ma (eastern ad central areas), and 3.5 Ma (Zenobito promontory), whereas Aldighieri *et al.* (1998) reported slightly older ages for the eastern ad central areas (7.25-7.59 Ma) and for Zenobito rocks (4.65 Ma). Such discrepancies are probably due to the different geochronological methods utilized by the two authors: Rb/Sr on whole rocks (Barberi *et al.*, 1986) and K/Ar on biotite (Aldighieri *et al.*, 1998). Capraia volcano consists of well defined sequences of lava flows, which have been grouped stratigrafically and geochemically. Available data provide geochronological control on the probable ages of each group and suggest that magmas have been emplaced during eruptive cycles with a duration of the order of 340 ky (Aldighieri *et al.*, 1998). A brief description of the different groups is given (Prosperini, 1993; Poli *et al.*, 1995):

1) Old series volcanites belong to the main and older emission centers whose lava flows cover the largest part of the island. These rocks have a seriate holocrystalline porphyritic texture with high phenocrysts contents (27-40%) formed by a mineralogical assemblage composed of plagioclase, clinopyroxene, rare ortopyroxene, olivine, biotite, and ilmenite, zircon, titanite and apatite as accessory phases.

2) Monte Campanile and Porto volcanites, outcropping in the central part of the eastern coast (Fig. 1); they have a seriate holocrystalline porphyritic texture with high phenocrysts contents (about 33-50%). They are composed of plagioclase, K-feldspar, clinopyroxene, rare ortopyroxene, biotite, Fe-Ti oxides and apatite.

3) Zurletto pyroclastics (ZRS) crop out in the eastern cost, probably originated from an external submerged centre (Fig. 1). ZRS rocks have vesiculated glassy texture with high phenocryst contents (about 20-34%). They are composed by plagioclase, K-feldspar, anphibole, clinopyroxene and biotite; apatite is present as inclusion in the main phases.

4) S. Rocco and Piano volcanites form small eruptive centers, disposed in a NE-SW direction (Fig. 1). These rocks have a porphyritic texture with 17-28% of phenocryst contents. Their phenocrystalline portion is constituted by plagioclase, clinopyroxene, olivine and biotite; apatite, titanite, zircon, ilmenite, magnetite and chromite are present as accessory minerals.

5) Laghetto volcanites crop out in a narrow depressed area on the top of the volcano (Fig. 1); they show a holocrystalline porphyritic texture with 22-57% of phenocrysts contents constituted by plagioclase, K-feldspar, clinopyroxene, biotite; accessory minerals are apatite, zircon, titanite, and Fe - Ti oxide.

6) Zenobito volcanites (ZBS) crop out in the southern part of the island forming a neck of porphyritic lava surrounded by stratified scoria deposits (Fig. 1). ZBS are in general vesciculated, lightly porphyric rock (14% of

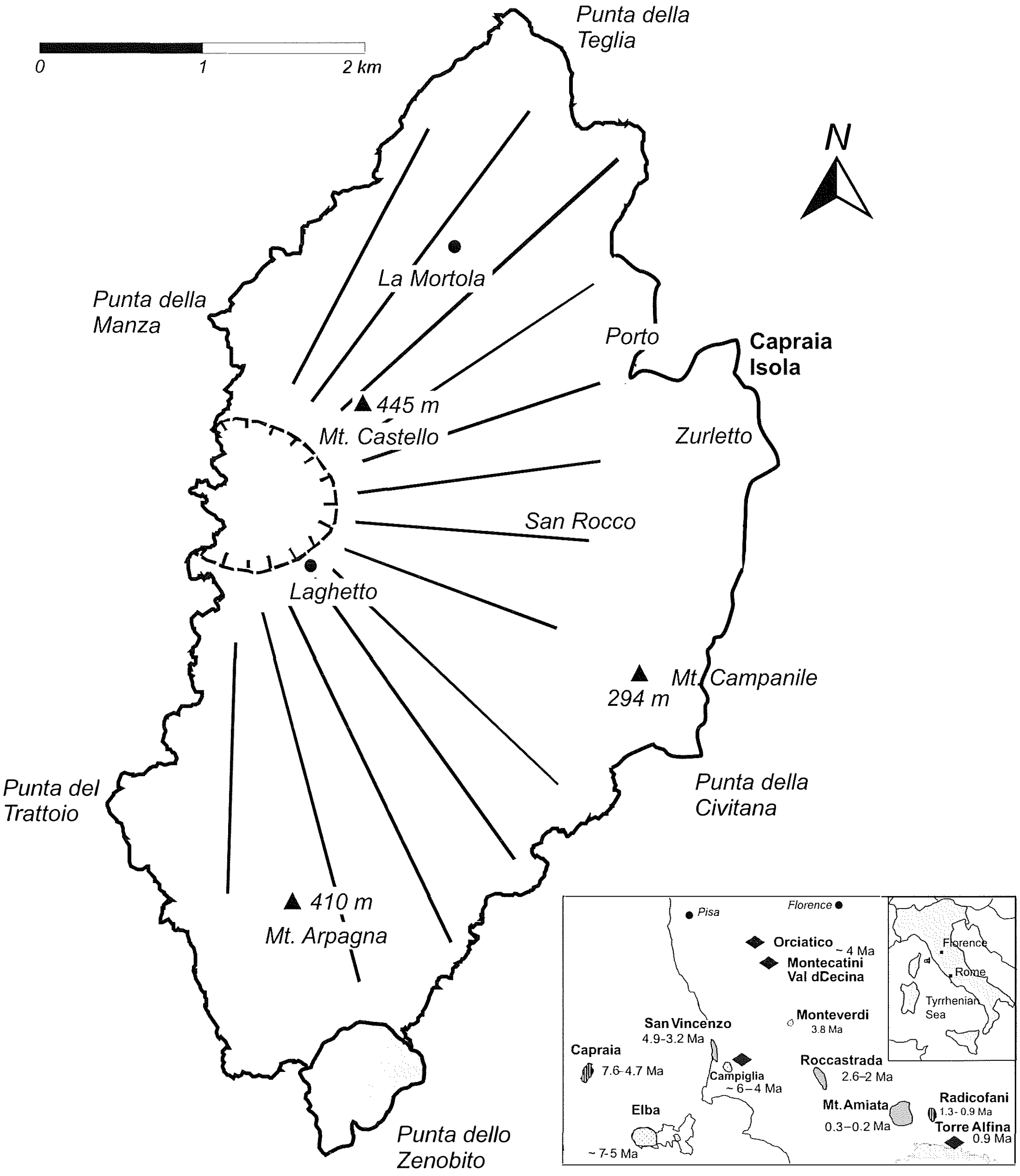

Fig. 1 – Schematic geological map of the island of Capraia.

phenocrysts content), having cryptocrystalline, hypocrystalline, and microcrystalline groundmass constituted by acicular plagioclase, ortho- and clinopyroxene, ilmenite, magnetite and chromite. Zoned olivine is the only phenocryst, with euhedral, somewhere skeleton habitus. Microphenocrysts of K-feldspar are occasionally observed.

5.3 GEOCHEMISTRY

Capraia rocks range in composition from shoshonitic basalts (ZBS), high-K andesites, and dacites (Fig. 2). It is noteworthy that, except ZBS and ZRS volcanites, the majority of Capraia volcanites have a narrow range on SiO_2. Consequently some major and trace element variations are illustrated in figure 3 using Cr as representative of the degree of evolution since its contents are more variable than silica.

Except ZBS rocks, Capraia volcanics do not exhibit primary magma composition, since they have quite low magnesium number, and compatible element contents. Ca, Fe, and Ti display a similar trend with highest values in the less evolved rocks, and lowest for the more differentiated group. Compatible elements such as Ni and Cr are enriched in the more basic rocks, and tend to be depleted in the more evolved one; Rb, Ba, and La contents increase toward the more evolved volcanites, being depleted in the basic one.

All the analyzed samples, but ZBS rocks, are relatively enriched in light REE and fractionated for both light and heavy REE. Laghetto vulcanites are characterized by the higher total abundance of REE and more fractionated heavy REE. Almost all the

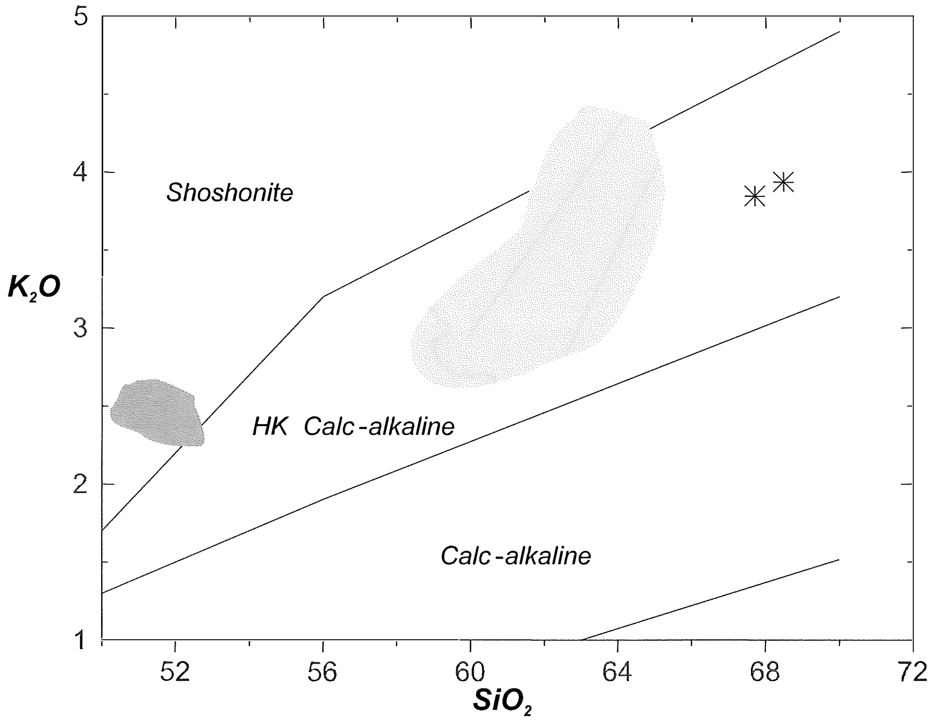

Fig. 2 – K_2O vs. SiO_2 diagram (Peccerillo and Taylor, 1976) for the rocks of Capraia. Dark gray region: Zenobito volcanites; light gray region: all the others volcanites; asterisks: Zurletto pyroclastics. Data from Prosperini (1993).

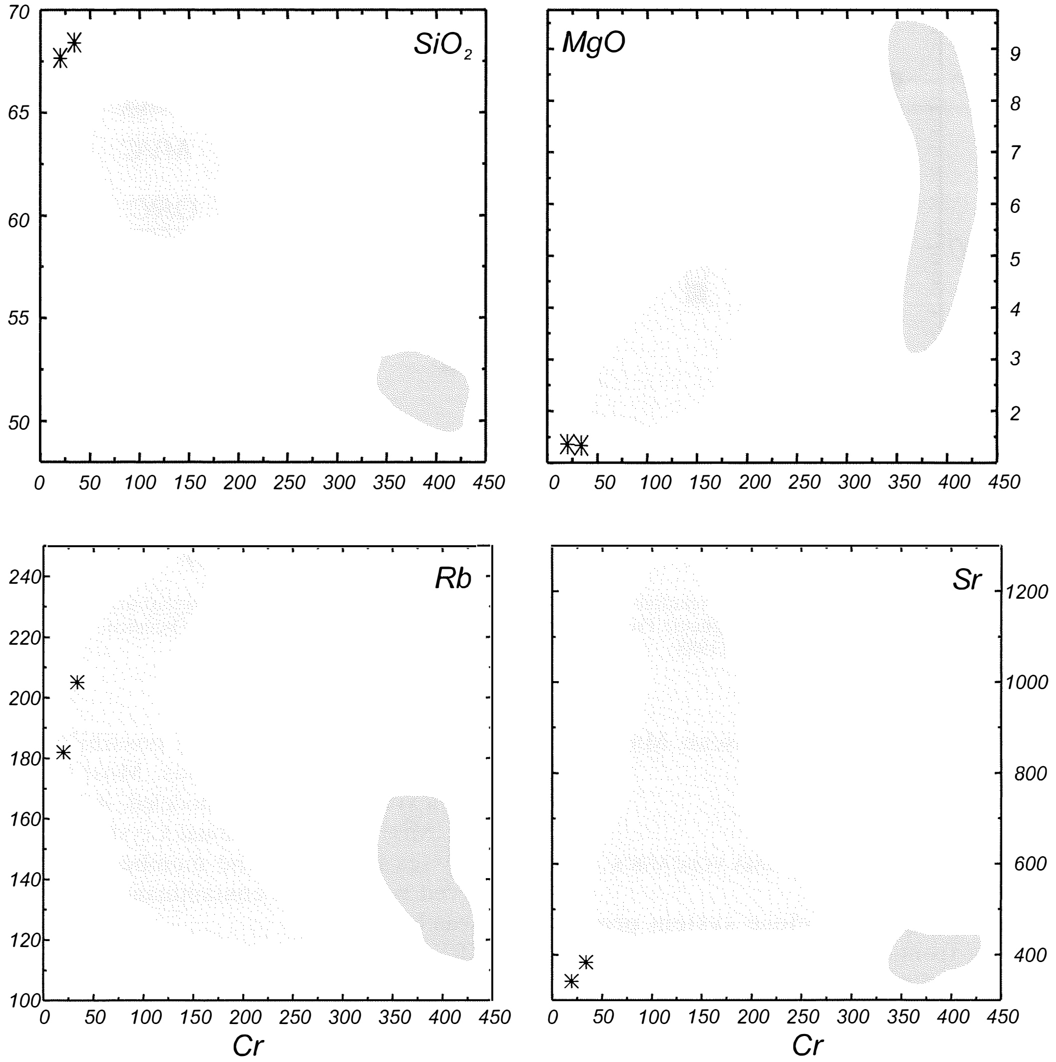

Fig. 3 – Selected major and trace inter-elemental diagrams for the rocks of Capraia. Cr is used as representative of the degree of evolution of Capraia rocks (see text for details). Symbols as in figure 2. Data from Prosperini (1993).

samples have significant negative Eu anomaly.

$^{87}Sr/^{86}Sr$ ratios have a very large range of values (0.7073 to 0.7102) evidencing that all Capraia rocks cannot be regarded as the products of simple close system petrogenetic processes.

Volcanites from Capraia Island display similar trends of Tuscan orenditic lavas, suggesting a tendence to an orenditic affinity for Capraia lavas (Fig. 4). Also Serri *et al.* (1991), using isotopic ratios, recognized a general correlation between Capraia rocks and

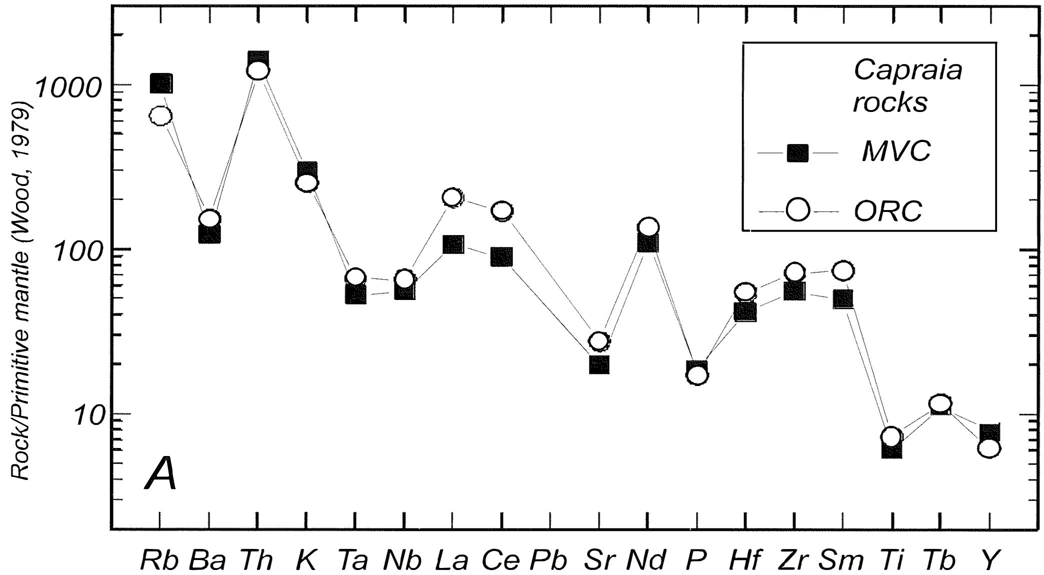

Fig. 4 – Spider diagram showing the relationships between the Capraia rocks (gray shaded region) and rocks with lamproitic affinity of the Tuscan Magmatic Province. MVC: Montecatini Val di Cecina; ORC: Orciatico. Data from Prosperini (1993) and Peccerillo *et al.* (1988).

the lamproites of the Tuscan Magmatic Province.

5.4 GENESIS OF CAPRAIA VOLCANICS

A single genetic close system process starting from a parental basic magma (e.g. crystal fractionation) is not adequate to explain the genesis of all the groups of Capraia rocks because of petrographic evidence of normal, reverse, patchy zoning plagioclases, together with sieved plagioclases, zoned and skeletal olivines, coexisting augitic and diopsidic pyroxenes, and turbid and break down biotite. This is confirmed by the variability of Sr isotopic ratios. Such features, on the contrary, lead to think that the history of those magmas is characterized by a complex evolution, often with the lack of equilibrium between mineralogical phases and melt. These features could be referred to other different differentiation processes than simple fractional crystallization, such as the possibility of interaction between magmas. Most of the Capraia volcanites can be modeled, in fact, by MFC (Mixing plus Fractional Crystallization) processes having as end-members the lest evolved rocks and a contaminant similar to Tuscan lamproites.

ZRS rocks cannot derive from the same process as they plot well outside the modelled trends. A possible petrogenetic process for ZRS could be related to a fractional crystallization coupled with assimilation process of crustal material with a fractionating assemblage made up mainly by plagioclase, biotite, +/- amphibole, apatite, zircon, and titanite starting from a rocks belonging to the near Campanile outcrops.

Regarding ZBS rocks it is to note that their genesis cannot be derived by a single parental magma, because they have different Sr isotopic ratios, more than one digit over the third decimal. Mixing between magmas at different Sr isotopic ratios could be a feasible hypothesis but this process can be ruled out on the basis of trace element geochemistry. Therefore, the most probable hypothesis for ZBS rocks is a provenance from different mantle batches.

5.5 Summary

Petrographical and geochemical data, coupled with quantitative models, are compatible with an evolutionary model for oldest products of Capraia volcano developing on several stages starting from a HK-calcalkaline magma evolving probably by simple fractional crystallization in a deep magma chamber. The products of such differentiation process also evolved by mixing plus fractional crystallization with a magma similar to the Tuscan Lamproites in a shallow magma chamber before extrusion, resulting in the old and Monte Campanile and Porto series. The same magma interacted with a deeper magma with completely different geochemical signature and evolved by mixing plus fractional crystallization, resulting in the San Rocco e Laghetto rocks. An evolved magma could have interacted with the crust to give the pyroclastic event of the ZRS rocks. Finally, after a period of 3.0 Ma, Zenobito shoshonitic batches of magmas with different geochemical characters were erupted.