Roman Alkaline Province, Italy

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Introduction

H.W. Washington, in 1906, visited this region surrounding Rome and through his petrographic and chemical studies of the volcanic rocks brought this area to the attention of petrologists throughout the world. Since then, many eminent petrologists and volcanologists have done research in the area and have made it a classic locality in every sense of the word.

The petrographic suite includes representatives of the best-known volcanic types and a variety of volcanic ejecta of peculiar chemical and mineralogical composition. The suite was collected under the direction of Professor G. Lombardi of the University of Rome, who also supplied the introductory notes, sample descriptions, chemical analyses, and a list of references. Our sincere thanks to Professor Lombardi.

Description and Location of Specimens

Most of northwestern Latium, the region of which Rome is the capital, is covered by volcanics in an elongated belt between the Tyrrhenian coast and the Apennine. The volcanics range in age from the Upper Pliocene to about 30,000 years. The volcanics include a wide compositional range from calc-alkaline to strongly alkaline and potassic. The volcanism of Latium is related to post Miocene extensional tectonics which formed the Tyrrhenian basin, and is located just west of the thick continental crust of the Apennine range. The volcanics of mainland Latium belong to two magmatic series.

The first volcanic series includes alkaline to strongly alkaline rhyolite, rhyodacite, and quartz latite volcanics in the Tolfa-Cerite-Manziate area (not included in this suite), and in the Mt. Cimino area (included in this suite, samples 1-3; unit 2 on the map). This volcanic series was characterized by the eruption of ignimbrites and lavas from about 2.5 MY ago to 1 MY ago.

The alkaline to strongly alkaline and potassic second series is the best known and makes up most of this suite (samples 4-21; unit 1a-1d on the map). It includes the Quaternary alkaline and potassic groups of Vulsini, Vico, Sagatini, and the Alban Hills, as shown on the index map. These rocks are related to alkaline and potassic volcanoes of the Campania Province to the south of Rome, including the areas of Roccamonfina, the Phlaegren Fields, and Vesuvius. Second series volcanism extended from about 800,000 years ago for the Vico Volcano to about 30,000 years for the Alban Hills area.

Volcanism of the first series occurred in topographically high areas. The alkaline-potassic volcanism of the second series developed in graben areas during an extensional tectonic phase. The volcanics cover more than 70% of northwestern Latium, and eruption products from the Alban Hills extend to 60 km south of Rome. Pyroclastics predominate over lava flows and domes. Petrographically, the most common rocks are range from trachyte and latite to tephrite, leucitite, and phonolite. The thickness of the second series is up to several hundred meters.

The alkaline-potassic second series is comprised of a number of separate phases of activity.

1) In the first phase, silica oversaturated trachyte to rhyolite were erupted, which were alkaline but only slightly potassic. These volcanics do not appear to have built well-defined volcanic edifices and were probably fed by fissure systems which seem to coincide with the areas of thickest volcanics. The age of the first phase was probably between about 900,000 and 800,000 years ago.
2) The first phase was followed regional extension and topographic collapse and the growth of large stratovolcanoes characterized by the production of mainly tephrite, trachyte, and phonolite. The trachyte is normally undersaturated in silica. The trend of volcanics from medium to the strongly potassic is typical of Mediterranean-type volcanics.
3) The next phase (from ~600,000 to 400,000 years ago) is characterized by the eruption of tens of km^3 of pyroclastic flows, in this phase mostly of mainly latite and trachyte. These rocks have a relatively weak potassic character and quite often with leucite but are only rarely undersaturated. One of the most significant petrochemical characteristics of the volcanics of this phase is the low content of Fe-Mg minerals even in the most mafic rocks of the series. The peculiar petrography of the volcanics at this phase, the almost contemporaneous eruption in the whole region, the enormous quantity of magma which erupted in a short time, are all related to regional extensional tectonics.
4) The next phase was characterized by the formation of collapse calderas in nearly all the volcanic areas, which were accompanied and followed by a variety of volcanic activity.
5) In the last phase, the extensional tectonics became complicated with dominantly strike-slip movement. This change was accompanied by less volcanism and characterized by more basic alkaline potassic rocks (Fe-Mg-rich) that ranged from dark latite to leucitite. The closing activity of this volcanic group is characterized by phreatomagmatic eruptions which led to the formation of peculiar pyroclastics with accretionary lapilli, and volcano-sedimentary structures including antidunes and crossed lamination structures throughout the Roman Province.

Specimen Descriptions

The volcanics primarily rest on a sedimentary basement which is indicated on the map by units 3, 4, 5, and 6. The specimens were chosen to provide a reasonable representation of the different petrographic types and different lithologies. A complete representation of all of the main facies of each series and phase was beyond the scope of this suite.

The specimens include representatives of the first, acidic volcanic series from Mt. Cimino, but most are from the more important alkaline-potassic series from Vulsini, Vico, Sabatini, and the Alban Hills volcanoes. The approximate location of each specimen is shown by the superimposed numbers on the accompanying geologic map.

1) Quartz latite ignimbrite from a quarry 3 km south of Vitor-chiano, Mt. Cimino. Age 1.2-1.4 MY. This ignimbrite has a thickness of up to 70 m and is from a plateau of 10-12 km radius centered around Cimino. At least 75% of the plateau is now covered by more recent products of the Vico volcano. This sample is from a grayish, compact facies with well-developed welded tuff structures. Abundant flattened and elongated scoria and pumice fragments are oriented along the stratification planes. Biotite and sanidine phenocrysts are abundant. Some sedimentary and contact metamorphic inclusions are minor components. Some fragments contain idocrase and/or garnet-rich metamorphic rocks. Analysis 1.

2) Quartz latite ignimbrite from a quarry north of Sorano del Cimino, Mt. Cimino. Age 1.2-1.4 MY. This specimen is a pinkish variety of the same ignimbrite as specimen 1. It also is rich in flattened, oriented scoria and pumice fragments as well as other volcanic inclusions.
3) No specimen. Quartz latite lava from a dome close to the top of Mt. Cimino. Age 1.0 MY. Several domes developed over an area of some 10-12 km^2. Their lavas are characterized by large (up to 12 cm) sanidine crystals. Other, smaller phenocrysts are sanidine, plagioclase (An50), biotite, OPX and CPX. Analysis 3.
4) Trachyte welded ash flow tuff of Vulsini, Canino area. This specimen represents the early activity of Vulsini which is found in limited outcrops at the northern edge of this volcanic group. Flattened, elongated, black pumice fragments occurred in an ash-rich groundmass where analcitized leucite, sanidine, and plagioclase are associated with volcanic and sedimentary inclusions.
5) Trachyte from a collapsed foam lava of Vulsini, Pitigliano (Case Collina) area. Age 200,000 years. This is an ignimbrite facies which overlies a thick pumice layer and underlies another foam lava flow. It was erupted in one of the last stages of activity in the northern part of the Vulsini volcanic group. It has a marked eutaxitic structure with volcano-sedimentary structures. Phenocrysts include leucite, sanidine, plagioclase, and CPX. Analysis 5.
6) Trachyte from Vico. This is one of the earliest lavas of the Vico volcano, outcropping on the south shore of Lake Vico, inside the caldera. Compact, greenish, fine-grained trachyte with euhedral sanidine phenocrysts. Incipient alteration is related to widespread fractures in the outcrop.
7) Leucite trachyte lava of Vulsini from the quarries of Ponzano. This specimen is from a 25 m thick lava flow layered between two pyroclastic flows. Lava degassing and flow led to the development of parallel sets of elongated vesicles. Gammetti and Beccauna (1968) give a mineralogical description of this facies. Groundmass 98%, dominantly sanidine with scarce labradorite, leucite, CPX, and altered biotite. Analysis 7.
8) Trachytic phonolite pumice of Vulsini from the Pitigliano area. Age 200,000 years. A product of one of the small vents that emitted heterogeneous products in the last stages of activity of this volcanic group. At Pitigliano the pumice constitutes a dome-shaped structure below a thick ignimbrite-foam lava cover. Rare phenocrysts of sanidine and CPX may be seen in this highly porous glassy rock. Analysis 8.
9) Tephritic phonolite to trachyte ignimbrite produced from a fissure eruption on Sabatini, from Grottarossa, near Rome (note that according to some geologists this unit was erupted from the Vico volcano). Age 400,000 years. It is characterized by an abundance of black glassy scoria and pumice fragments from a few to 80 cm in diameter. Dense facies grade into altered, loose material. The fresh rock is dark gray but when analcimitized it typically has a yellow-reddish color. Phenocrysts of leucite, sanidine, plagioclase, pyroxenes, biotite, and lava inclusions are distinguished macroscopically in the pumice. In addition to analcite, the zeolites chabazite and phillipsite are common in the groundmass and vacuoles.
10) Trachyte pumice fragments isolated from specimen 9 above. Age 500,000 years. Very fresh euhedral sanidine (analcimized) and leucite phenocrysts are in a fresh glassy groundmass. Analysis 10.
11) Leucite tephrite lava of Vico, from Borghetto, close to Civita-Castellana. This is one of the earliest products of the Vico Volcano, and is found ~20 km east of the central vent. It is characterized by very large, fresh leucite crystals and is part of a large lava flow that is up to 20 m thick.

12) Leucite tephrite lava of the Alban Hills, from Fosse della Mola, Rocca Prioria. This fine-grained lava is bedded between scoria and lapilli tuffs of the external eruptive system of the Alban Hills volcanic group. Nepheline and subordinate olivine may be present. Analysis 12 is from a very similar lava from the same volcanic group but not from this locality. This specimen is compared to a leucitite lava of the central eruptive system of the Alban Hills, specimen 15.
13) Scoria of the Alban Hills, Fosso della Mola, Rocca Priora. A scoriaceous, blackish and yellowish material collected just above the lava flow where specimen 12 was collected. This is an example of how different patterns of vesiculation lead to a lithologically different final product, but which maintains its chemical similarity to the original magma.
14) Tephritic leucitite lava from Sabatini, from the Monterosi lava flow. This specimen is from a fine-grained aphanitic grayish lava which is one of the major flows found bedded between dominant pyroclastic units.
15) Melilitic leucitite of Alban Hills, Capo de Bove, Rome. This specimen is from one of the lava flows made famous by H.S. Washington. It underlies the final part of the Old Appian Way, and the specimens were collected 290 m from this Roman road which is paved with slabs of this rock. The flow originated from the central eruptive system of the Alban Hills volcanic group. The rock is compact, fine-grained, with a few leucite and pyroxene phenocrysts. Analysis 15.
16) Red leucite-bearing tephrite scoria from Vulsini, Valentano. Age <200,000 years. At this locality, a major cinder cone was formed during one of the last stages of activity at Vulsini, at the margin of the Latera caldera, one of the largest volcanic structures of this group. This material has been altered, and with slaked lime is used for mortar.
17) Lahar from the Alban Hills from Marino. Age <200,000 years. A sample from a large mudflow with thickness up to 60 m, which formed at the margin of the Lake Albano crater. It is rich in inclusions of sedimentary, metamorphic and volcanic materials. Chunks of contact metamorphic rocks and volcanics such as leucite-bearing lavas and pyroclastics are found. This rock is used in the building stone industry. Some is cut into slabs as thin as 2 cm. Others are used for sculpture stone and artistic decorations. Analysis 17 is from very similar material close to Albano.
18) Phreatomagmatic pyroclastics of the Alban Hills. Age <200,000 years. From the rim of the Lake Albano crater. In the last stage of alkaline-potassic volcanism in the Roman Province, phreatomagmatic eruptions occurred at a number of centers. This specimen is mainly composed of ash and shows crossed laminations and accretionary lapilli structures. Lapilli from this locality have diameters of 1-20 mm, and are composed of very fine ash graded from 10 μm in the core to <2 μm at the rim. The core is often made up of a small lava fragment. NaCl enrichment is found in this facies.
19) Volcanic ejecta of the Alban Hills, Marino. In this volcanic group there are pyroclastic units and cinder cones having extreme mineralogical compositions. Minerals which have been found include leucite, pseudoleucite, kalsilite, sodalite, haune, nepheline, melilite, biotite, olivine, garnet, pyroxenes, spinels, and apatite.
20) Biotitite ejecta from the Alban Hills, Marino. From the same locality as sample 10. This ejecta is characterized by a dominance of biotite.
21) Leucite-rich volcanic ejecta of the Alban Hills, Via Ardeatina. Ejecta is composed dominantly of leucite or pseudoleucite, collected from a pyroclastic unit stratigraphically below the lava of specimen 20. This sample is similar in composition to the italite types.

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Chemical analyses of samples

Major elements in weight % of the oxides

Sample	1	3	5	7	8	10	12	15	17
SiO_2	61.77	61.26	56.70	55.68	57.25	57.88	45.82	45.99	39.66
TiO_2	0.73	0.70	0.57	0.12	0.47	0.65	0.99	0.37	0.80
Al_2O_3	15.95	16.14	19.19	17.85	17.69	20.30	16.42	16.56	14.99
Fe_2O_3	1.48	2.31	2.08	2.34	1.50	1.62	6.33	4.17	4.65
FeO	2.70	2.25	1.83	3.60	1.23	1.65	2.43	5.38	2.80
MnO	0.10	0.08	0.13	0.14	0.15	0.27	0.23	-	0.14
MgO	2.28	2.65	1.44	2.57	0.42	0.75	4.01	5.30	4.29
CaO	4.38	4.68	4.38	5.40	2.62	3.01	10.70	10.47	13.75
Na_2O	2.31	2.35	2.50	2.64	3.65	4.04	1.05	2.18	2.42
K_2O	5.57	5.39	9.25	7.83	9.64	6.72	8.31	8.97	6.12
P_2O_5	0.25	0.30	0.30	0.40	0.09	0.10	0.67	0.56	0.14
CO_2									2.83
H2O+	1.83	1.58	1.01	1.15	3.91	2.68	1.30	0.65	3.41
H2O-	0.44	0.53	0.19	-	0.92	0.22	0.64	-	1.64
Total	99.79	100.22	99.57	99.72	99.54	99.89	98.90	100.60	97.64

Trace elements in ppm

Zr						590			370
Ba						450		2200	540

Explanation and references.

1) Quartz latite ignimbrite, Mt. Cimino, average of four analyses (Puxeddu, 1971).
3) Quartz latite lava, mt. Cimino (Puxeddu, 1971).
5) Trachyte collapsed foam lave of Vulsine (Locardi, 1965).
7) Leucite trachyte lava of Vulsini (Giammetti and Beccaluva, 1968).
8) Trachy phonolite pumice of Vulsini (Santacroce, 1970).
10) Trachyte pumice (Scherillo, 1940).
12) Leucite tephritic lava from alban Hills (Osteria de Colonna lava flow, Fornaseri, et al., 1962).
15) Melilite lucitite from Alban Hills (Fornaseri, et al., 1963).
17) Mudflow pyroclastics of Alban Hills (Fornaseri, et al., 1963).

Inferences on the volcanic history of the Vico volcano, Roman Magmatic Province, central Italy: stratigraphic, petrographic and geochemical data.
Perini, G. ; Conticelli, S. ; Francalanci, L. Mineralogica et Petrographica Acta 1997 . v 40/- 67-93

Vico is a central stratovolcano with a polygenetic caldera. Its activity spans between 419 and 95 ka and is characterized by an alternance of explosive and effusive eruptions. Stratigraphic logs, petrographic and geochemical data of rocks outpoured during the whole volcanic history of the Vico volcano are here reported. Three periods of activity have been recognized on the basis of geological and geochemical data. The first period of activity (419- 400 ka) was dominated by

pyroclastic fall deposits, which show a variable degree of silica saturation and compositions ranging from latite to rhyolite. Among the products of the first period of activity, alkali increase while the degree of silica saturation decreases with time. During the second period (300-138 ka) the main edifice was built up by numerous lava flows of variable petrographic and chemical composition (leucite- and sanidine- bearing lavas), followed by four final parossistic events that brought to the formation of the summit caldera. Most of the products of the second period were generally mildly to strongly silica undersaturated, characterized by leucite-bearing rocks belonging to the high potassium series (HKS of the Roman Magmatic Province), with a variable composition from phono-tephrite to phonolite. Minor volumes of rocks with lower alkali contents, having latitic to trachytic compositions were also emitted during this period. During the third period both explosive and effusive eruptions occurred. These were emplaced both inside and outside the caldera walls and they vented from peri-caldera fractures and intra-caldera vents. With respect to the rocks of the second period those of the third period are less alkali-rich, and some of them resemble those of the Roman Potassium series (KS). They range in composition from trachybasalts to latites, although some tephri- phonolites and phonolites are still present.

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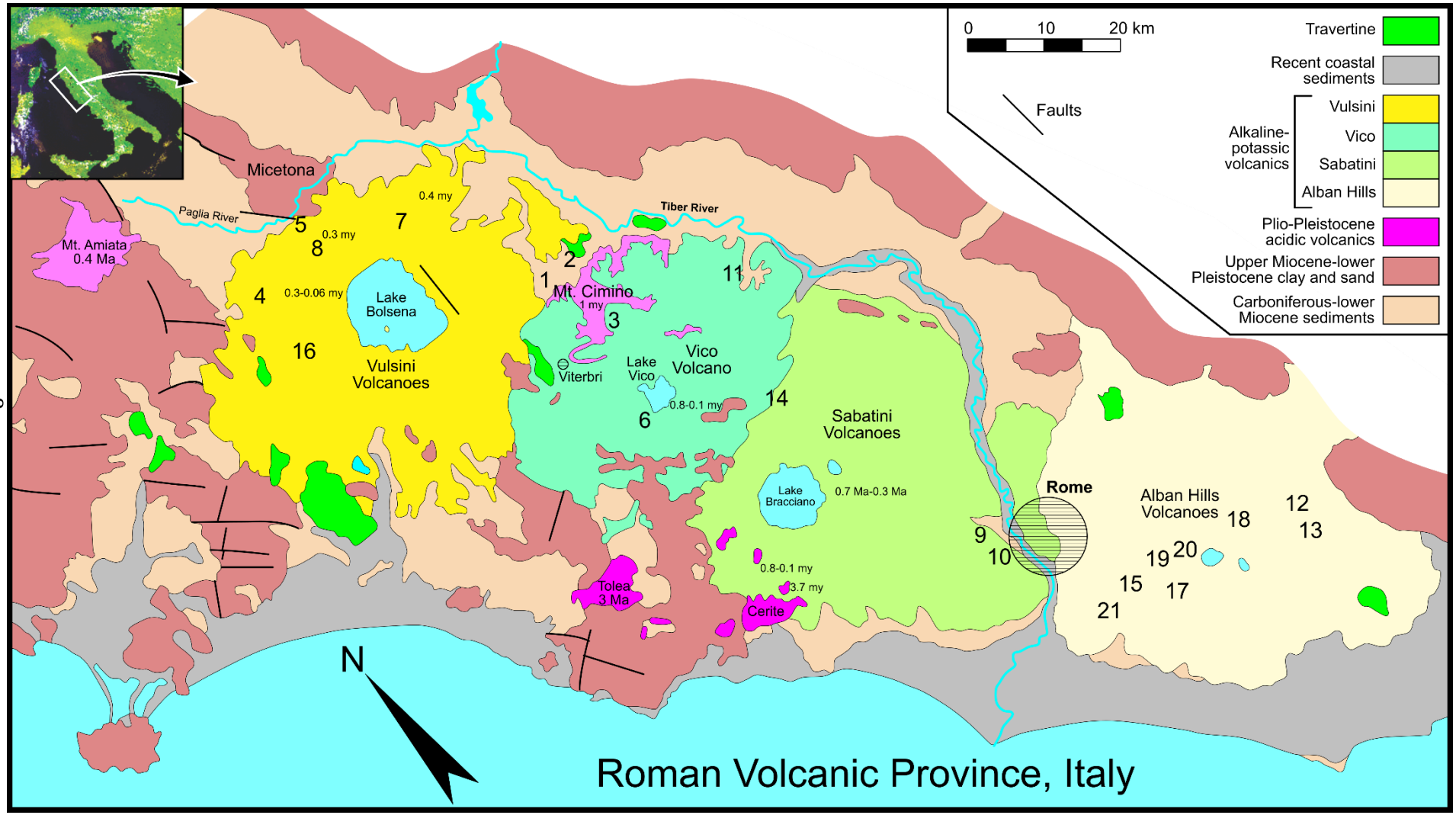
0 10 20 km
Travertine
Recent coastal sediments
Faults
Alkaline-potassic volcanics
Vulsini
Vico
Sabatini
Alban Hills
Plio-Pleistocene acidic volcanics
Upper Miocene-lower Pleistocene clay and sand
Carboniferous-lower Miocene sediments
Micetona
Paglia River
Tiber River
Mt. Amiata 0.4 Ma
0.4 my
0.3 my
0.3-0.06 my
Lake Bolsena
Vulsini Volcanoes
Mt. Cimino 1 my
Viterbi
Lake Vico
Vico Volcano
0.8-0.1 my
Sabatini Volcanoes
Lake Bracciano
0.7 Ma-0.3 Ma
Rome
Alban Hills Volcanoes
Tolea 3 Ma
3.7 my
Cerite
N
Roman Volcanic Province, Italy