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CHEMISTRY OF THE LAVAS AND TEPHRA FROM THE RECENT (A.D. 1631-1944) VESUVIUS (ITALY) VOLCANIC ACTIVITY

By

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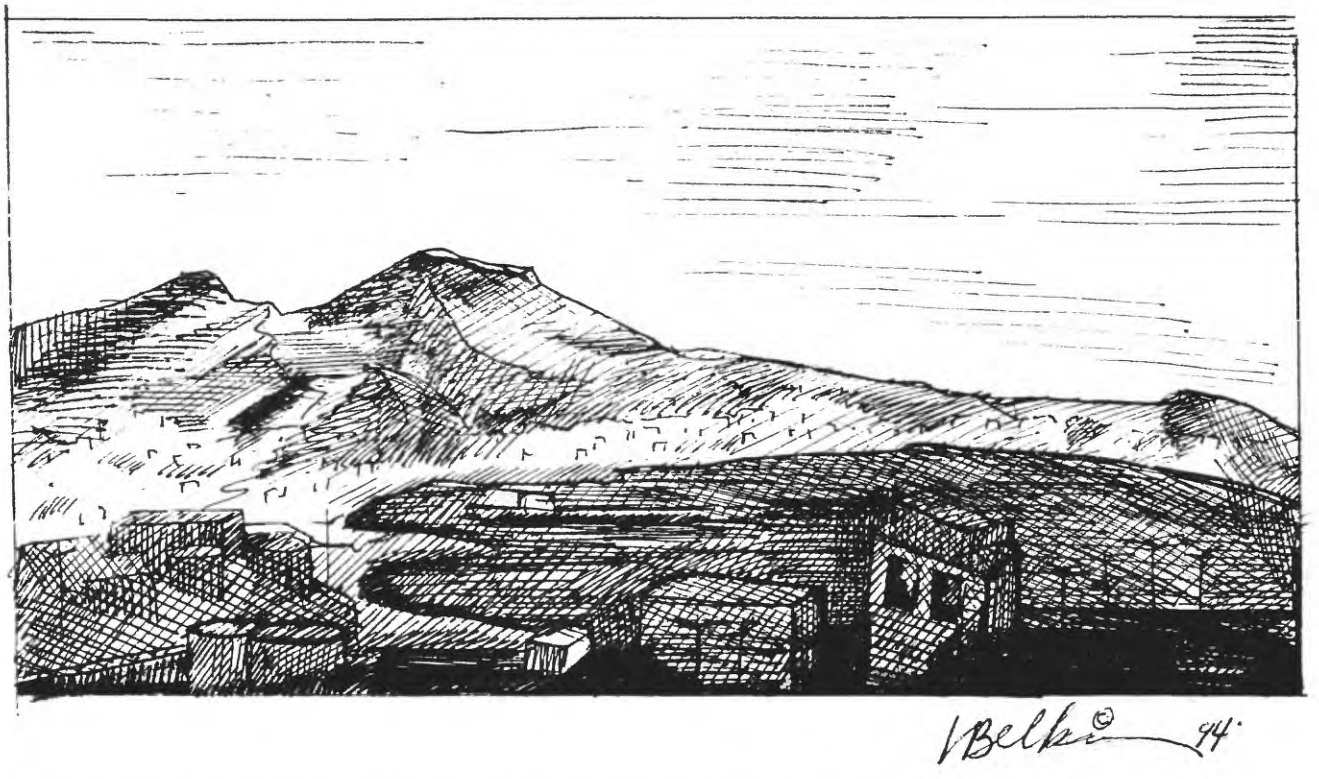

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INTRODUCTION AND GEOLOGIC SETTING

The A.D. 1631 eruption of volcano Vesuvius, in Naples, Italy, began more than 300 years of nearly constant eruptive activity. The succeeding activity was predominately effusive with only minor pyroclastic events usually at the end of an eruptive cycle. This continuous, relatively low energy activity made Vesuvius an ideal laboratory for volcanologists and petrologists until its last eruption in A.D. 1944. The literature pertaining to Vesuvius begins with Pliny the Younger's letter to Tacitus describing the A.D. 79 "Pompei" eruption and continues today as new studies continue to add to the body of work used to interpret and model its past and perhaps future activity. Systematic study and chemical analysis of the Vesuvius products began with Johnston-Laves (1884) and Washington (1906), respectively. Recent studies are discussed by Barberi et al., (1981) and Santacroce (1983). Modern analytical work is reviewed by Joron et al. (1987). This report presents the comprehensive chemical database which has been determined as part of an ongoing study (Belkin et al., 1991; Belkin et al., 1993) of the petrogenesis of the recent A.D. 1631-1944 Vesuvius activity. The data generated by such an analytical program will provide a base for use in petrologic analysis as well as in derivative and complementary studies such as detailed modal and chemical petrography and isotopic analysis. The importance and utility of such a unified data set arises from the fact that although Vesuvius has been extensively studied, few workers have presented complete analyses.

Mt. Somma-Vesuvius is part of the Roman potassic province of Washington (1906) located east of Naples, at the southern boundary of the Campanian plain. Mt. Somma-Vesuvius is a composite volcano that has erupted silica-undersaturated and potassium-rich lavas and pyroclastics for at least 25,000 years. The eruptive history of Somma-Vesuvius can be divided into three periods; (1) the early historic period before the A.D. 79 "Pompei" plinian eruption, (2) the middle period covering A.D. 79 to 1631 and (3) the recent period of activity from A.D. 1631 to 1944. The most recent eruptive period represents an almost continuous series of mild, mostly effusive lavas ranging in composition from phonolitic-leucitite to tephritic-leucitite. The average SiO_2 content is 48.0 wt.% and the rocks are classified as tephriphonolites according to their alkali (K_2O + Na_2O) content. All of the lavas are silica-undersaturated and are nepheline, leucite, and olivine normative.

The proximity of Vesuvius to the resources and study of renaissance and post-renaissance Europe plus recent detailed mapping (Rosi et al., 1987) has provided historical documentation for the reconstruction of this recent period. We have used as a base for sampling (figs. 1, 2, 3, and 4) the recent map of Rosi et al., (1987). A recent compilation and discussion of the eruptive history, chemistry, petrography, and geophysics of Mt. Somma-Vesuvius can be found in Santacroce (1987) and references therein.

All the flows consist of moderately viscous lavas with either aa or pahoehoe surfaces. They are homogeneous in appearance, either vesicular or massive, and phaneritic with well developed leucite or pyroxene phenocrysts. Arnó et al., (1987) has divided the recent period activity into 18 eruptive cycles. These cycles start with the A.D. 1638 effusive activity. The question of the existence of lavas erupted with the A.D. 1631

explosive activity is contentious. For the purpose of this report, we will consider those rocks labelled as pre-A.D. 1631 by Rosi et al., (1987) to be A.D. 1631 lavas (figs. 1, 2, 3, and 4).

Arnó et al. (1987) defined eighteen eruption cycles (Table 1) for the recent period of activity based on the collection, interpretation, and synthesis of historical data. Quiescent periods between episodes never exceeded seven years. The cycle typically closed with more vigorous eruptions perhaps resulting from external sources (e.g., earthquakes) (Arnó et al., 1987). These final-cycle eruptions are thought to empty the shallow magma reservoir. Apparently only 1-7 years was necessary to refill the lava column within the conduit. After re-establishment of the lava column strombolian activity typically begins a new cycle.

Table 1. Eighteen cycles of Vesuvius recent activity defined by Arnó et al., (1987).

cycle 1	A.D. 1638-1682
cycle 2	A.D. 1685-1694
cycle 3	A.D. 1696-1698
cycle 4	A.D. 1700-1707
cycle 5	A.D. 1712-1737
cycle 6	A.D. 1742-1761
cycle 7	A.D. 1764-1767
cycle 8	A.D. 1770-1779
cycle 9	A.D. 1783-1794
cycle 10	A.D. 1799-1822
cycle 11	A.D. 1825-1834
cycle 12	A.D. 1835-1839
cycle 13	A.D. 1841-1850
cycle 14	A.D. 1854-1861
cycle 15	A.D. 1864-1868
cycle 16	A.D. 1870-1872
cycle 17	A.D. 1874-1906
cycle 18	A.D. 1907-1944

METHODS

Sampling

Representative samples of bedrock or quarry outcrops were collected, labelled, and located (figs. 1, 2, 3, and 4) on the 1:25000 geologic base of Rosi et al., (1987). Samples from locations that were later judged to be uncertain are not included. Appendix A summarizes the location and field notes. Obviously weathered or altered samples were avoided. The data reported here were obtained from aliquants ground in tungsten carbide at the University of Rome, Italy or from aliquants ground in Reston, Virginia using a jaw crusher with hardened Mn-steel plates and a grinder with alumina plates.

The following abbreviations for various analytical techniques are used in the

discussions below; ion exchange separation - inductively coupled plasma atomic emission spectrometry (IES/ICP-AES), inductively coupled plasma atomic emission spectrometry (ICP-AES), atomic absorption spectrometry (AAS), instrumental neutron activation analysis (INAA), wavelength dispersive X-ray fluorescence spectrometry (WDXRF), energy dispersive X-ray spectrometry (EDXRF), F - selective ion electrode (F-SIE), Cl - selective ion electrode (Cl-SIE), and S - combustion/IR spectrometry (S-C/IRS).

The description of the methods that follows was adapted from the summaries supplied by the analysts for each method; for a more complete discussion of the various analytical methods used in this report the reader is referred to Baedecker (1987).

Analysis of Major Element Oxides

Major element oxides (Si, Al, Fe^{total}, Mg, Ca, Na, K, Ti, P, Mn) were determined in representative aliquots by WDXRF using the method of Taggart et al., (1987). Total iron was determined as Fe_2O_3. The true value of Fe_2O_3 was calculated after FeO determination. 800 mg samples are weighed and then ignited in a Pt-Au crucible at 900 to 925°C for 45 minutes. The samples are reweighed after cooling to determine the total loss on ignition (LOI). The ignited samples are then fused with 8 g of lithium tetraborate by heating at 1120°C for 40 minutes, poured into Pt molds, and the resultant glass disc is irradiated by X-rays generated by a Rh-target tube operating at 35 kV and a current of 60 mA. Characteristic X-rays emitted by each element in the sample are counted, corrected for matrix effects using the deJongh (1973) model, and the concentrations are determined using previously prepared calibration standards. The concentration data are then recalculated to account for any mass change on ignition.

Analysis of FeO

The method used is that of Peck (1964). A 500 mg sample is decomposed using HF and H_2SO_4. The resultant solution is treated with boric and phosphoric acids. Fe^{2+} is determined by a colorimetric or a potentiometric titration with potassium dichromate. Sodium diphenylamine sulfonate is used as the endpoint indicator in the colorimetric titration.

Analysis of CO_2, H_2O-, and H_2O+.

CO_2 - The method of Engleman et al. (1985) was used. A 500 mg sample is first digested with $HClO_4$. Any CO_2 that is evolved is carried into a coulometric cell. The CO_2 is converted into a strong acid by ethanolamine, and is titrated coulometrically.

H_2O- - A 1 g sample is weighed and dried at 110°C for a minimum of 1 hour. The sample is placed in a desiccator and cooled. The sample is weighed again and the H_2O^- is determined by difference (Shapiro, 1975).

H_2O+ - The method of Jackson et al. (1987) was used. A 50 mg sample is mixed with 150 mg of lead oxide/lead chromate flux. The sample is heated to 950°C. The evolved water is determined coulometrically by a Karl-Fischer titration. The titration yields the total H_2O in the sample. H_2O^+ is thus determined from the difference between total H_2O and H_2O^-.

Analysis of S, Cl, and F.

Sulfur: The combustion/IR spectroscopy method of Kirschenbaum (1983) was used. A 200 mg sample is weighed and vanadium pentoxide is added as a combustion aid. The mixture is combusted in a sulfur analyzer and the sulfur dioxide is measured by an infra-red detector.

Chlorine: A 200 mg sample is decomposed using $KMnO_4$, HF, and H_2SO_4 in a specially designed, sealed teflon vessel. Chlorine is captured in a KOH/Na_2SO_3 solution in the center compartment of the container and then determined as chloride by the selective ion electrode method of Aruscavage and Campbell (1983).

Fluorine: A 100 mg sample is fused with a Na_2CO_3/ZnO flux. The fusion cake is leached with H_2O. HCl is added to liberate any CO_2. An aliquot of the sample solution is buffered with a sodium citrate/KNO_3 solution. This solution is analyzed for fluorine, as fluoride, by the selective ion electrode method of Kirschenbaum (1988).

Analysis of Cr, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb, Ba, La, and Ce by EDXRF

Approximately 1.0 g of 100-mesh, powdered sample is pressed into a Mylar cup. Samples are analyzed using a Kevex 700 EDXRF spectrometer with a Kevex 7000 analyzer (Johnson, 1984; Johnson and King, 1987). The secondary targets used to fluoresce each element were: Cr = Iron; Ni, Cu, and Zn = Germanium; Rb, Sr, Y, Zr, and Nb = Silver; Ba, La, and Ce = Gadolinium. Corrections are made for background interferences, escape peaks, and spectral overlaps. Sources of error inherent to EDXRF analysis are corrected using the Compton ratio method. Trace element concentrations in the samples are calculated from calibration graphs of the intensity ratio versus concentration for a series of standard reference materials found in Abbey (1983).

Analysis of Nb by IES/ICP-AES

A 100 mg sample is decomposed with HNO_3, $HClO_4$, and HF and evaporated to dryness overnight. The residue is dissolved in 15 mL of 8N HCl. The solution is passed through an ion exchange column to remove the alkali metals. The chloride form of Nb is absorbed onto the resin. The column is washed with 5N HF to remove Fe. A solution of 7N HNO_3 is poured through the column to quantitatively strip the Nb from the resin. This fraction is collected and evaporated to dryness. The residue is dissolved in 2 mL of 2N HCl and analyzed by ICP-AES. Estimates of detection limits are given by Wilson et al. (1987).

Analysis of Be, Li, Ni, V, and Y by ICP-AES

A 100 mg sample is decomposed with HNO_3, $HClO_4$, and HF and evaporated to dryness overnight. The residue is dissolved in 10 mL of 2N HCl. Analysis of Be, Li, Ni, V, and Y is done directly on this solution by ICP-AES (Lichte et al., 1987). Ni at <20 ppm was analyzed by the graphite-furnace atomic absorption spectrometry method.

Analysis of Pb by AAS

A 100 mg sample is decomposed with HNO_3, $HClO_4$, and HF and evaporated to dryness overnight. The residue is dissolved in 10 mL of 2N HCl. Analysis of Pb was

done directly on the solution by flame atomic absorption (Aruscavage and Crock, 1987).

INAA

Sample aliquants of ~0.5 g each are irradiated for 6-8 hours at a flux of ~$2x10^{12}$ n-cm^{-2}-s^{-1} in the "TRIGA" reactor at the U.S. Geological Survey, Denver, Colorado. Standards for most elements are aliquants of a powdered natural obsidian spiked with primary solutions, taken to dryness and homogenized. Standards for Ca, Ti, and Au are powdered $CaCO_3$, TiO_2, and homogeneous low-Au quartz, respectively. At least one replicate sample and one USGS standard rock are irradiated together with the samples and standards. Samples are counted three times on co-axial Ge and/or Ge(Li) detectors with resolutions ranging from 1.78 to 1.86 KeV measured at 1.33 MeV using the following scheme: 1 hour counts after 6-8 days of decay, 2 hour counts after 14-17 days of decay, and 2-4 hour counts ~50 days after irradiation. In addition, one count is done on an intrinsic Ge, low-energy photon detector (for one hour, 8-10 days after irradiation).

Gamma-ray spectra are analyzed for Na, K, Ca, Sc, Ti, Cr, Fe, Co, Ni, Zn, As, Se, Rb, Sr, Zr, Mo, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Au, Th, U, and W using the appropriate isotopes. Computer processing is done with SPECTRA and associated programs on a VAX11/780 computer or an IBM-PC compatible computer (Grossman and Baedecker, 1987; Baedecker and McKown, 1987; Baedecker and Grossman, 1989). Corrections are made for spectral interferences as well as for interferences on Zr, Mo, Ba, La, Ce, and Nd from the products of ^{235}U fission produced during irradiation.

DATA TABLE EXPLANATIONS

One hundred and forty-nine lavas and five tephra have been analyzed. Three tables (Tables 2, 3, and 4) present the complete chemical data set acquired by chemists in the U.S. Geological Survey laboratories located in Reston, Virginia, Denver, Colorado, and Menlo Park, California. The following analysts are all from the Branch of Geochemistry, U.S. Geological Survey; P.A. Baedecker, J.N. Grossman, and G. Wandless (INAA), M.W. Doughten (IES/ICP-AES and AAS), J. Kent and J.R. Evans (EDXRF), C.J. Skeen (Cl-SIE & S-C/IRS), J.R. Gillison-Colbert (F-SIE), H. Smith, M.G. Kavulak, W.B. Crandell, and C.L. Prosser (FeO, CO_2, H_2O+ and H_2O-), J. Taggart, J.S. Mee, A. Bartel, and D.F. Siems (WDXRF).

All tables

The data for the major elements and volatiles are given usually to two decimal places except SiO_2, Al_2O_3, and FeO. The Fe_2O_3 reported in the tables was derived by the following equation; $Fe_2O_3 = Fe_2O_3^{total} - (FeO \cdot 1.1113)$. Values reported as upper limits (e.g., < 0.01) are included but were at or below the indicated detection limit. The samples are listed in each table from the oldest to the youngest date of eruption and within each date, they are listed by decreasing MgO value. Other abbreviations are na = not analyzed or reported, LOI = loss on ignition, and FeOT = total iron calculated

as FeO.

All the major elements and volatiles given in Table 2, 3, and 4 were analyzed by the techniques described above. However, some elements were determined by more than one analytical procedure. In the explanation of the tables below, the particular preferred analytical technique selected for these elements is identified. Although all intermethod biases are believed to be less than 20%, in some cases the detection limits differ significantly.

TABLE 2 EXPLANATION

Table 2 represents 103 lava analyses that were selected as representative of their particular eruptions and were subsequently analyzed by INAA.

Analysis code a = the sample submitted for INAA was an aliquant of the rock that was ground in Reston, VA with steel/alumina as described above.

Analysis code b = the sample submitted for INAA was an aliquant of the rock that was ground in Rome, Italy with tungsten carbide as described above.

Sc - INAA
Cr - INAA
Co - INAA
V - ICP-AES
Ni - ICP-AES
Zn - INAA
Cu - EDXRF
W - INAA
Mo - INAA
Sb - INAA
As - INAA
Li - ICP-AES
Be - ICP-AES
Zr - EDXRF
Hf - INAA
Nb - IES/ICP-AES = analysis code c; EDXRF = analysis code d
Ta - INAA
Th - INAA
U - INAA
Rb - EDXRF
Cs - INAA
Sr - EDXRF
Ba - EDXRF
Pb - AAS
Y - ICP-AES
La - INAA
Ce - INAA
Nd - INAA
Sm - INAA
Eu - INAA
Tb - INAA
Yb - INAA
Lu - INAA
Au - INAA

Table 2 miscellaneous notes: The Pb value for sample V77 was confirmed by duplicate analysis. The Au value for V39 was checked to verify that it was not an instrumental error.

TABLE 3 EXPLANATION

Table 3 presents 5 tephra that were analyzed by INAA. The analytical technique preferences and codes are the same as those defined in table 2.

TABLE 4 EXPLANATION

Table 4 presents 46 lava analyses and represents the remainder of the lavas. Cr, Ni, Zn, Cu, Zr, Nb, Rb, Sr, Ba, Y, La, and Ce were all determined by EDXRF.

DATA AVAILABILITY

Digital versions of the data tabulated in this report are available on double-sided high-density (1.2 MB) 5¼" floppy diskettes and double-sided high-density (1.4 MB) 3½" floppy diskettes in a form compatible with the IBM-PC versions of QUATTRO PRO or LOTUS 1-2-3 spreadsheets. The data are also available on double-sided low-density or high-density diskettes compatible with MACINTOSH Computer using a EXCEL spreadsheet. Either version can be obtained from the senior author; please send a diskette with instructions concerning compatibility.

SAMPLE LOCATIONS

We have used as a base for sampling (figs. 1, 2, 3, and 4) the recent map of Rosi et al., (1987) that includes new mapping plus historical reconstruction.

Explanation of sample location maps

The pertinent geographic area containing the recent flows has been divided up into three sections, western (fig. 1), central (fig. 2), and eastern (fig. 3) as noted in fig. 4. The 1:25000 scale map of Rosi et al. (1987) has been simplified in terms of the map patterns that distinguished the volcanic products of the period A.D. 1637-1944 (fig. 4). Appendix A provides details of the locations. The three maps are reproduced at a scale of 1:50000.

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APPENDIX A

List of the samples of A.D. 1631-1944 Vesuvius recent products (collected in 1988 by CRJK). Samples located using the 1:25000 geological map of Somma-Vesuvio by Rosi et al., 1987. Where appropriate, locations are given as direction and distance from the center of the Gran Cono (GC), the central cone of Vesuvius.

Abbreviations: TA = Torre Annunziata; TG = Torre del Greco; M = Samples cut by "marble" cutter, not in Dipartimento di Geofisica e Vulcanologia; SUM = summit

LAVA SAMPLES

Sample No.	Full Reference	Location
V1	V/1631/2TA	Torre Annunziata; Lido, NR Terme Vesuviane.
V2	V/1631/3TA	as V1.
V3	V/1631/4TA	as V1.
V4	V/1631/3TG	Torre del Greco; FS Stazione.
V5	V/1631/4TG	as V4.
V6	V/1631/5	Torre Annunziata; Stazione Sta Maria la Bruna.
V7	V/1631/7	as V6.
V8	V/1694/1	5 km W GC; 750 m ESE Cim. di Resina.
V9	V/1694/2	as V8.
V10	V/1694/3	as V8.
V11	V/1697/1	Torre del Greco; Campo Sportivo; 4.25 km SW GC.
V12	V/1697/1M	as V11.
V13	V/1697/2	as V11.
V14	V/1697/2M	as V11.
V15	V/1697/3M	Torre del Greco; NE of Autostrada; 5 km SE GC.
V16	V/1714/1M	Boscotrecase Road; 5 km SSE GC.
V17	V/1714/2	SSW Massa del Carceriere; 3.75 km SE GC.
V18	V/1717/1M	Cappella Nuova; 4.2 km S GC.
V19	V/1717/2M	as V18.
V20	V/1723/1	Terzigno; Campo Sportivo; 3.7 km ENE GC. [Note: what is mapped as a 1723 dagala maybe 1906 material]
V21	V/1737/1	200 m N Casa Serpe; 3.25 km SW GC.
V22	V/1737/2	as V21.
V23	V/1737/3	Fosso Bianco; 2.75 km SW GC.
V24	V/1737/4	as V23.
V25	V/1751/1	Boscoreale; Villa Massa; 6.4 km SE GC.
V26	V/1751/2	as V25.
V27	V/1751/3	as V25.
V28	V/1754/1	N branch; 3.8 km SE GC.
V29	V/1754/3	N branch; 5.3 km SE GC.
V30	V/1754/4	S branch; Boscoreale (Balzani); 4.8 km SE GC.
V31	V/1760/1	Torre Annunziata; C. Ranieri; 7 km S GC.
V32	V/1760/2M	as V31.
V32a	V/1760/2M	as V31; thin section only.
V33	V/1760/3	as V31.
V34	V/1760/4	W of Berardinelli; 5.1 km S GC.
V35	V/1760/5M	as V34.
V36	V/1760/6	100 m S of vent area; 4.1 km S GC.

V37	V/1760/7	as V36.
V38	V/1760/8	E of Massa S. Giorgio; 4.9 km S GC.
V39	V/1767/1	toe of flow; N of Cim. di Portici; 5.5 km WSW GC.
V40	V/1767/2	N of San Vito; 4.3 km WNW GC.
V41	V/1767/3	as V40.
V42	V/1761-71/1	Torre del Greco; 3.25 km WSW GC.
V43	V/1761-71/3M	Torre del Greco; facing Casa Rossa; 3.5 km WSW GC.
V44	V/1794/2	Torre del Greco; lowest vent area; 3 km SW GC.
V45	V/1794/3	as V44.
V45a	V/1794/4	Torre del Greco; Port; 6.5 km SE GC (100 m NW V46); thin section only.
V46	V/1794/6	Torre del Greco; Port; 6.5 km SW GC.
V47	V/1794/7	Torre del Greco; SE margin of flow; 6.3 km SW GC.
V49	V/1805/1	S branch; 750 M NE Camaldoli; SE of C. Luciniello; 4.5 km SSW GC.
V50	V/1805/2	as V49.
V51	V/1805/3	as V49.
V52	V/1805/4	middle branch; near Villa Cervasio 4.5 km SSW GC.
V53	V/1806/1	S branch; 750 m E of Camaldoli; 4.7 km SSW GC.
V54	V/1806/2	S branch; 375 m N Cappella Nuova; 4 km SSW GC.
V55	V/1806/3	as V54.
V56	V/1806/4	N branch; 375 m NE Lamaria; 5 km SW GC.
V57	V/1806/5	as V56.
V58	V/1822/1	forestale; 2 km S GC.
V59	V/1822/3	forestale; 2.1 km S GC.
V60	V/1822/4	forestale; 2.6 km S GC.
V61	V/1834/2M	quarry 600 m NW Boccia al Mauro; 6.3 km ESE GC.
V62	V/1834/3	as V61.
V63	V/1834/6	as V61.
V64	V/1834/8	WSW of Terzigno; 3.1 km SE GC.
V65	V/1839/1M	S of Terzigno; 5.7 km ESE GC.
V66	V/1839/2	S of Terzigno; 5.1 km ESE GC.
V67	V/1839/3	as V66.
V68	V/1847/1a	forestale; 1.9 km SW GC.
V69	V/1847/2M	forestale; 2.1 km SE GC.
V70	V/1850/1	W margin of exposure; 1.9 km SSE GC.
V71	V/1850/2	2 km SSE GC.
V72	V/1850/3	2.1 km SSE GC.
V73	V/1855/1	N branch; S. Sebastiano (dagala); 5.9 km WNW GC.
V74	V/1855/1M	as V73.
V75	V/1855/2	N branch, W toe; S. Sebastiano; 6.75 km WNW GC.
V76	V/1855/3M	as V75.
V76a	V/1855/3M	as V75; thin section only.
V77	V/1855/4	as V75.
V78	V/1858/1	forestale; 1.3 km W GC.
V79	V/1858/2	N side of road to Ercolano; 4 km WNW GC.
V80	V/1858/3	E side of road to Ercolano; 3.5 km W GC.
V81	V/1858/4M	as V80.
V82	V/1858/5	N side of road to Ercolano; 3 km WNW GC.
V83	V/1861/2	Torre del Greco, Hospital; 4 km SW GC.
V84	V/1861/3	Torre del Greco; toe of flow; 4.75 km SW GC.
V85	V/1867/1	forestale; 1.5 km S Colli Umberto; 1.3 km SE GC.
V86	V/1867/2	as V85.

V87	V/1868/1	quarry face N of Stazione Inferiore della Funivia; two thin sections; covered by 1872 lava; 4 km ENE GC.
V87a	V/1868/2	as V87.
V88	V/1871-72/1	toe of flow; NW of C. Cerasiello; 3,7 km WSW GC.
V90	V/1872/2a	forestale; 1.8 km SW GC.
V91	V/1872/2	N branch; S. Sebastiano; 5.5 km WNW GC.
V92	V/1872/3	S branch; S. Sebastiano; 4 km WNW GC.
V92a	V/1872/4	above S. Sebastiano; 2.75 km WNW GC; thin section only.
V93	V/1881/1	tumulus on ESE flank of GC ("750 m ESE GC").
V93g	V/1881/1	glassy sample, thin section only; as V93.
V94	V/1881/2	as V93.
V95	V/1883-1906/1	Cognoletta; 2 km SE GC.
V96	V/1886/1	forestale; 2 km SW GC.
V97	V/1891-94/1	between C. Margherita & Umberto; 1 km NNW GC.
V98	V/1891-94/2M	between C. Margherita & Umberto; 1 km NW GC.
V99	V/1895-99/1	forestale; 1.9 km WNW GC.
V100	V/1895/99/2	as V99.
V101	V/1895-99/3	E side of Colli Umberto; 1.25 km NW GC.
V102	V/1895-99/4	NW side of Colli Umberto; 1.75 km NW GC.
V104	V/1906/3	as V105.
V105	V/1906/3M	N Boscotrecase; middle branch, E limb; 6.3 km SSE GC.
V106	V/1906/4B	N Boscotrecase; middle branch, W limb; 4.6 km SSE GC.
V107	V/1906/7M	W branch; E of C. Aniello; 4 km SSE GC.
V108	V/1906/8M	as V107.
V108a	V/1906/8M	as V108; thin section only.
V108b	V/1906/8M	as V108; thin section only.
V109	V/1906/10	within Somma Caldera; Piazzale; 1.3 km SE GC.
V110	V/1906/12M	as V109.
V111	V/1913-44/1	Valle dell'Inferno; 1.6 km E GC.
V112	V/1913/44/2	Valle dell'Inferno; 1.6 km ESE GC.
V113	V/1929/1M	S branch; NE of Terrioni; 3.6 km SE GC.
V114	V/1929/3	N branch; Terzigno, S side of road to Campo Sportivo; 4.4 km ESE GC.
V115	V/1929/3	as V114.
V116	V/1929/4	N branch; Terzigno, S side of road Sportivo (NW); 3.6 km ESE GC.
V117	V/1929/5	N branch, S margin; 3.3 km ESE GC.
V118	V/1929/6M	as V117.
V119	V/1929/7M	S branch; S of Buscodi Cupaccia; 2.8 km SE GC.
V120	V/1941-42/1	hornitoes; 1.55 km SE GC.
V121	V/1941-42/1	hornitoes; 1.5 km SE GC.
V122	V/1944/1/?	Main (S. Sebastiano) flow; 2.25 km NW GC.
V123	V/1944/1/1a	as V122.
V124	V/1944/1/1a	as V122.
V125	V/1944/1/1b	as V122.
V126	V/1944/1/1c	as V122.
V127	V/1944/1/1d	main flow; by road; 2.5 km NW GC.
V128	V/1944/1/2a	main flow; Colle Margherita; 1.25 km NNE GC; 3 orthogonal thin sections.
V129	V/1944/1/2b	as V128.
V130	V/1944/1/2c	as V128.
V131	V/1944/1/2d	as V128.
V132	V/1944/1/3	main flow; tumulus, Atrio del Cavallo; 1.1 km NNE GC.

V133	V/1944/1/4	main flow, W margin; 1 km N GC.
V134	V/1944/1a/1	main flow, N branch, N side; 4.4 km NW GC.
V135	V/1944/1a/2	as V134; 2 thin sections.
V135a	V/1944/1a/3	as V134; thin section only.
V135b	V/1944/1a/4	main flow, N branch ; S side opposite V134; 4.4 km NW GC; thin section only.
V136	V/1944/1a/6M	N side of 1872 dagala; 3.5 km NW GC.
V136a	V/1944/1a/6	as V136; thin section only.
V136b	V/1944/1a/5	as V136; thin section only.
V137	V/1944/1a/7	main flow, N branch, N limb; S. Sebastiano; 5.5 km NW GC.
V138	V/1944/1b/1M	main flow, S branch; S of 1872 dagala; 3 km NW GC.
V138a	v/1944/1b/1	as V138; thin section only.
V139	V/1944/1b/2M	main flow, S branch; S of 1872 dagala; 3.2 km NW GC.
V139a	V/1944/1b/2	as V139; thin section only.
V140	V/1944/2a	Colle Margherita; toe of flow; 1 km NW GC.
V141	V/1944/3a	Colle Margherita; toe of flow; 1.2 km NW GC.
V142	V/1944/4/1a	forestale; 1.4 km W GC.
V142a	V/1944/4/1b	as V142; thin section only.
V143	V/1944/5/1	forestale; toe of N tongue; 1.5 km SE GC.
V143	V/1944/5/3	forestale; as V143; thin section only.
V144	V/1944/5/2	forestale; 1.4 km SE GC.
V145	V/1944/6/1p	forestale; 1.55 km S GC.
V145a	V/1944/6/1	as V145; thin section only.
V146	V/1944/6/2	forestale; toe of eastern tongue; 1.9 km S GC.
V147	V/1944/6/3	forestale; W margin; 1.6 km S GC.
V148	V/1944/SUM/1	S rim of GC.
V149	V/1944/SUM/2	SW rim of GC.
V149a	V/1944/SUM/3	NNW flank GC, close to rim, thin section only.
V150	V/1906/13	N branch, near toe; Molara; 4.1 km SE GC.
V151	V/1906/14	as V150.
V154	V/1906/17	as V155.
V155	V/1906/18	middle branch, S limb; S Boscotrecase, Circumvesuviana Railway; 6.75 km SSE GC.
V156	V/1944/D1	toe of debris flow; by road, 1 km NNW GC; thin section only.

TEPHRA SAMPLES

Sample Number	Location
V44T1	1944; 1.1 km NNE GC.
V44T2	1944; 1.1 km NNE GC.
V44T3	1944; rim of Somma Caldera; 1.75 km SE GC.
V06T1	1906; from collection of Dipart. Geofisica e Vulcanologia, Napoli, location unknown.
V06T2	1906; from collection of Dipart. Geofisica e Vulcanologia, Napoli, location unknown.

Table 2: *Vesuvius lavas (A.D. 1631-1944)*

Sample no.	V4	V6	V3	V2	V9	V10
Date A.D.	1631	1631	1631	1631	1694	1694
Laboratory no.	W-255757	W-255692	W-255758	W-255693	W-246236	W-255753
Analysis code	a,c	a,c	a,c	a,c	b,d	a,c
SiO2 (wt.%)	48.2	47.5	48.4	48.4	48.1	48.1
TiO2	0.96	1.01	0.93	0.92	0.97	0.99
Al2O3	14.9	17.3	17.7	17.8	16.1	16.6
Fe2O3	5.33	5.03	3.16	4.37	3.63	4.06
FeO	2.5	3.4	4.7	3.6	4.3	4.0
MnO	0.14	0.15	0.15	0.15	0.14	0.14
MgO	6.55	4.31	3.69	3.68	5.43	5.05
CaO	11.8	9.81	8.44	8.33	10.6	10.2
Na2O	1.78	2.22	2.63	2.72	2.32	2.42
K2O	6.20	7.12	7.89	8.06	6.54	6.80
H2O+	0.28	0.28	0.47	0.41	0.16	0.16
H2O-	0.05	0.06	0.12	0.22	0.02	0.08
P2O5	0.81	0.92	0.79	0.78	0.87	0.89
CO2	0.02	0.01	0.02	<0.01	0.01	0.01
F	0.21	0.22	0.26	0.25	0.19	0.19
Cl	0.16	0.48	0.55	0.05	0.42	0.34
S	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
-O=F,Cl,S	0.13	0.22	0.26	0.12	0.19	0.18
Total	99.76	99.60	99.64	99.62	99.61	99.88
FeOT (wt.%)	7.30	7.93	7.54	7.53	7.57	7.66
LOI (wt.%)	0.19	0.11	0.31	0.32	<0.01	0.03
Fe3+/Fe2+	1.9	1.3	0.6	1.1	0.8	0.9
Sc (ppm)	29.9	15.80	12.88	12.76	25.6	26.0
Cr	193	20.5	26.6	24.9	77.5	78.5
Co	30.5	30.0	26.6	26.5	na	29.7
V	251	251	236	223	241	242
Ni	63	29	25	27	38	37
Zn	76	80	80	81	74	74
Cu	118	116	119	97	117	115
W	3.7	6.7	6.8	7.3	na	4.4
Mo	2.7	5.5	5.8	4.7	3.6	<5
Sb	0.41	0.35	0.51	0.475	0.22	0.30
As	8.8	7.8	11.4	8.1	7.8	8.2
Li	15	15	20	20	13	14
Be	7.8	7.8	9.6	11	7.0	7.1
Zr	174	195	220	197	198	202
Hf	4.07	4.47	4.74	4.77	4.63	4.65
Nb	24	28	35	37	23	28
Ta	1.39	1.65	2.04	2.00	na	1.62
Th	14.47	19.0	22.2	22.5	19.4	19.2
U	4.76	5.35	7.20	7.45	6.25	6.22
Rb	262	277	308	345	280	287
Cs	15.17	17.5	18.1	18.3	17.5	18.1
Sr	841	1040	1110	1160	853	874
Ba	1700	2130	2190	2260	1790	1860
Pb	32	36	43	25	28	29
Y	27	29	28	27	26	26
La	39.0	53.9	54.9	54.9	48.0	48.3
Ce	77.8	106.7	103.7	105.1	97.1	95.8
Nd	34.3	47.9	41.4	47.5	43.3	42.7
Sm	8.99	11.19	9.64	9.92	10.37	10.54
Eu	2.02	2.48	2.22	2.21	2.35	2.35
Tb	0.944	1.08	0.989	0.975	1.14	1.028
Yb	1.98	2.25	2.31	2.22	2.07	2.05
Lu	0.269	0.300	0.301	0.292	0.305	0.281
Au (ppb)	<7	<6	<6	<7	<6	<7

Table 2:

Sample no.	V8	V13	V14	V15	V16	V17
Date A.D.	1694	1697	1697	1697	1714	1714
Laboratory no.	W-255691	W-246240	W-255726	W-255725	W-255732	W-255755
Analysis code	a,c	b,d	a,c	a,c	a,c	a,c
SiO2 (wt.%)	48.0	47.7	47.6	47.7	48.3	48.2
TiO2	0.99	1.04	1.04	1.04	0.98	0.97
Al2O3	17.5	17.1	17.1	17.1	16.0	17.1
Fe2O3	7.33	3.25	3.15	2.85	3.55	3.62
FeO	1.1	4.9	5.0	5.3	4.4	4.3
MnO	0.15	0.14	0.14	0.15	0.14	0.14
MgO	4.32	4.51	4.48	4.46	5.55	4.77
CaO	9.15	9.99	9.92	9.94	11.0	9.69
Na2O	2.48	2.36	2.37	2.36	1.96	2.52
K2O	7.13	7.20	7.22	7.17	6.48	6.80
H2O+	0.14	0.27	0.12	0.35	0.31	0.36
H2O-	0.04	0.03	0.10	0.03	0.03	0.10
P2O5	0.91	0.96	0.96	0.95	0.78	0.88
CO2	0.04	0.01	0.01	0.01	<0.01	0.01
F	0.27	0.22	0.25	0.22	0.18	0.19
Cl	0.23	0.44	0.44	0.41	0.27	0.29
S	0.03	<0.01	0.03	<0.01	<0.01	<0.01
-O=F,Cl,S	0.19	0.21	0.24	0.20	0.15	0.16
Total	99.62	99.91	99.70	99.84	99.78	99.78
FeOT (wt.%)	7.69	7.83	7.84	7.86	7.59	7.56
LOI (wt.%)	0.33	0.11	0.09	0.08	0.06	0.35
Fe3+/Fe2+	6.0	0.6	0.6	0.5	0.7	0.8
Sc (ppm)	19.1	17.68	17.8	17.8	26.8	21.4
Cr	38.1	11.8	12.3	11.6	107	47.3
Co	29.0	na	30.1	30.3	31.3	28.6
V	231	244	254	262	246	231
Ni	31	34	33	34	48	32
Zn	79.4	76	81	79.1	77.9	73
Cu	113	126	130	112	100	119
W	3.8	na	5.9	5.5	4.0	5.9
Mo	3.8	<6	3.4	4.3	<6	2.7
Sb	0.404	0.346	0.39	0.421	0.34	0.48
As	8.8	5.0	5.8	8.8	7.6	9.6
Li	15	17	17	18	13	15
Be	7.8	8.4	8.5	9.0	7.4	7.3
Zr	210	202	199	199	174	206
Hf	4.81	4.46	4.47	4.48	3.95	4.62
Nb	31	27	30	30	22	30
Ta	1.85	na	1.71	1.84	1.38	1.78
Th	22.1	16.9	16.3	17.4	13.98	21.6
U	6.71	5.79	5.47	6.12	4.42	6.34
Rb	299	294	288	283	282	258
Cs	20.5	17.2	17.0	17.2	14.45	16.9
Sr	944	1040	1020	985	907	946
Ba	2020	2040	2010	2030	2020	2040
Pb	57	27	30	31	27	30
Y	30	27	26	27	26	26
La	53.4	44.6	44.1	46.0	42.8	56.1
Ce	108.0	89.0	86.7	90.4	84.8	109.4
Nd	50.9	41.6	41.2	41.2	38.6	49.3
Sm	11.06	9.66	9.57	9.97	9.92	11.21
Eu	2.43	2.18	2.20	2.27	2.25	2.49
Tb	1.069	1.07	0.995	1.029	0.990	1.07
Yb	2.27	2.22	2.21	2.27	2.14	2.13
Lu	0.298	0.318	0.294	0.308	0.278	0.292
Au (ppb)	6	<4	<5	<6	<5	<6

Table 2:

Sample no.	V18	V19	V20	V23	V24	V21
Date A.D.	1717	1717	1723	1737	1737	1737
Laboratory no.	W-255731	W-255721	W-255764	W-255742	W-255756	W-255763
Analysis code	a,c	a,c	a,c	a,c	a,c	a,c
SiO2 (wt.%)	48.0	48.2	47.7	47.9	48.0	47.7
TiO2	0.96	0.97	1.00	0.97	0.97	0.97
Al2O3	18.0	18.0	16.6	17.5	17.7	17.6
Fe2O3	5.66	3.12	3.72	3.93	6.28	7.68
FeO	2.5	4.8	4.8	4.4	2.3	1.0
MnO	0.15	0.15	0.15	0.15	0.15	0.15
MgO	3.77	3.75	4.91	3.90	3.89	3.83
CaO	8.44	8.57	10.7	9.14	9.11	9.03
Na2O	2.56	2.42	2.13	2.47	2.36	2.44
K2O	7.76	7.96	6.43	7.45	7.40	7.36
H2O+	0.38	0.47	0.36	0.33	0.24	0.28
H2O-	<0.01	0.02	0.14	<0.01	0.07	0.19
P2O5	0.89	0.90	0.86	0.86	0.86	0.85
CO2	0.01	0.01	0.05	0.02	0.11	0.04
F	0.24	0.22	0.17	0.22	na	0.23
Cl	0.38	0.35	0.20	0.49	na	0.37
S	<0.01	<0.01	<0.01	<0.01	na	<0.01
-O=F,Cl,S	0.20	0.19	0.12	0.22	na	0.20
Total	99.50	99.72	99.79	99.51	99.44	99.52
FeOT (wt.%)	7.59	7.60	8.14	7.94	7.95	7.91
LOI (wt.%)	0.50	0.39	0.40	0.31	0.35	0.68
Fe3+/Fe2+	2.0	0.6	0.7	0.8	2.5	6.9
Sc (ppm)	12.48	12.02	23.1	16.0	15.61	15.9
Cr	17.1	16.8	29.4	24.6	23.9	25.3
Co	27.5	27.2	29.7	28.4	28.3	28.5
V	217	224	267	240	243	231
Ni	28	27	28	24	23	23
Zn	82	80	75	85	81	79
Cu	122	114	120	143	131	155
W	4.6	5.4	5.4	6.3	5.2	5.6
Mo	<6	2.9	<4	4.0	<4	2.6
Sb	0.50	0.45	0.32	0.405	0.45	0.35
As	8.8	9.4	7.4	8.1	9.8	3.6
Li	21	19	14	16	16	18
Be	10	9.7	7.2	8.0	8.8	8.6
Zr	203	203	195	220	216	225
Hf	4.20	4.15	4.51	5.12	5.10	5.17
Nb	30	33	28	31	31	31
Ta	1.92	1.87	1.56	1.86	1.83	1.86
Th	19.4	18.9	15.24	21.3	21.3	20.6
U	6.62	6.72	4.84	6.94	6.93	5.94
Rb	323	331	213	295	291	298
Cs	20.6	20.1	14.1	20.4	20.4	19.9
Sr	1060	1070	906	987	937	986
Ba	2170	2220	2060	2020	1940	1960
Pb	40	34	24	34	32	35
Y	26	25	27	26	28	27
La	48.5	47.7	41.9	52.1	52.8	48.5
Ce	92.8	90.6	84.7	103.3	103.8	96.3
Nd	39	39.0	37.6	47.2	45.6	44.5
Sm	9.39	9.13	9.68	10.94	10.75	10.34
Eu	2.15	2.11	2.20	2.42	2.43	2.32
Tb	0.940	0.926	0.983	1.06	1.06	1.003
Yb	2.19	2.18	2.31	2.31	2.27	2.18
Lu	0.294	0.288	0.289	0.308	0.303	0.296
Au (ppb)	7	6	<6	<5	<8	<6

Table 2:

Sample no.	V25	V29	V28	V30	V36	V31
Date A.D.	1751	1754	1754	1754	1760	1760
Laboratory no.	W-255737	W-255720	W-255738	W-255740	W-255710	W-255739
Analysis code	a,c	a,c	a,c	a,c	a,c	a,c
SiO2 (wt.%)	48.3	48.2	48.2	49.3	48.0	47.9
TiO2	0.98	0.99	0.85	0.71	0.97	0.98
Al2O3	16.1	16.9	18.9	19.8	15.2	15.8
Fe2O3	3.33	2.17	6.40	4.37	2.44	3.89
FeO	4.6	5.7	1.7	2.6	5.2	4.0
MnO	0.14	0.14	0.15	0.15	0.14	0.14
MgO	5.51	4.91	3.08	1.96	6.31	5.74
CaO	10.9	10.0	8.09	7.17	11.9	11.1
Na2O	1.82	2.46	2.87	3.31	2.00	2.23
K2O	6.50	6.59	7.86	8.56	5.91	6.29
H2O+	0.24	0.32	0.13	0.35	0.48	0.24
H2O-	0.15	0.07	0.16	0.07	0.11	0.06
P2O5	0.79	0.89	0.72	0.40	0.84	0.86
CO2	0.01	0.01	0.06	<0.01	0.01	0.03
F	0.18	0.18	0.18	0.15	0.12	0.19
Cl	0.19	0.25	0.61	0.45	0.30	0.47
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.13	0.14	0.24	0.18	0.13	0.21
Total	99.61	99.63	99.72	99.17	99.80	99.72
FeOT (wt.%)	7.59	7.65	7.46	6.53	7.40	7.50
LOI (wt.%)	0.34	0.06	0.25	0.39	0.15	0.07
Fe3+/Fe2+	0.7	0.3	3.4	1.5	0.4	0.9
Sc (ppm)	25.2	21.6	9.11	5.68	33.9	27.7
Cr	94.5	41.8	9.9	8.4	135	91.5
Co	31.0	28.8	25.3	18.6	31.4	30.1
V	252	247	227	167	267	261
Ni	45	34	17	7.8	49	41
Zn	76.6	76.8	83.2	85.2	76.5	77.8
Cu	91	124	94	34	123	123
W	4.9	5.7	5.3	6.8	3.5	6.4
Mo	<3	4.8	<1	5.3	3.3	2.9
Sb	0.57	0.34	0.38	0.55	0.21	0.31
As	30.7	9.1	7.9	7.0	4.5	7.7
Li	13	15	20	25	13	13
Be	7.4	7.6	8.8	11	5.9	6.2
Zr	170	211	218	232	191	200
Hf	3.89	4.75	4.52	4.22	4.74	4.70
Nb	21	30	37	42	24	28
Ta	1.40	1.82	2.15	2.36	1.50	1.62
Th	14.11	22.0	25.2	25.7	18.1	19.1
U	4.53	6.32	7.28	8.80	5.28	6.15
Rb	283	251	290	338	238	246
Cs	15.05	15.55	18.7	19.5	15.46	16.5
Sr	889	935	1170	1310	823	853
Ba	2010	2040	2190	2260	1730	1800
Pb	28	32	38	40	29	30
Y	26	28	27	26	28	27
La	43.1	56.7	64.1	60.2	46.9	49.6
Ce	87.2	110.3	120.7	109.7	96.4	97.7
Nd	42.0	49.7	48.8	42.3	47.6	44.3
Sm	10.04	11.49	10.96	9.18	10.80	10.90
Eu	2.27	2.49	2.41	2.06	2.43	2.44
Tb	1.008	1.07	1.021	0.928	1.10	1.06
Yb	2.08	2.23	2.25	2.44	2.17	2.03
Lu	0.279	0.292	0.302	0.314	0.279	0.287
Au (ppb)	<7	17	7	10	<6	<5

Table 2:

Sample no.	V34	V38	V42	V43	V39	V41
Date A.D.	1760	1760	1761	1761	1767	1767
Laboratory no.	W-255709	W-255708	W-255741	W-246271	W-255719	W-255759
Analysis code	a,c	a,c	a,c	b,d	a,c	a,c
SiO2 (wt.%)	48.0	47.8	48.2	48.0	47.8	47.6
TiO2	0.98	0.97	0.96	1.00	0.98	1.08
Al2O3	16.1	17.3	17.4	17.8	17.5	17.7
Fe2O3	3.45	3.33	3.48	3.66	3.34	3.06
FeO	4.4	4.6	4.7	4.8	4.7	5.4
MnO	0.14	0.14	0.15	0.15	0.15	0.15
MgO	5.52	4.57	4.17	3.73	4.25	4.07
CaO	10.9	9.52	9.52	8.95	9.11	9.00
Na2O	2.33	2.52	2.61	2.63	2.58	2.72
K2O	6.41	7.09	7.11	7.42	7.34	7.28
H2O+	0.24	0.31	0.34	0.39	0.31	0.31
H2O-	0.01	0.08	0.17	0.10	0.08	0.24
P2O5	0.88	0.90	0.82	0.89	0.91	1.01
CO2	0.01	0.02	0.01	0.01	0.02	0.02
F	0.19	0.23	0.20	0.19	0.19	0.21
Cl	0.52	0.37	0.40	0.45	0.44	0.25
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.22	0.20	0.19	0.20	0.20	0.15
Total	99.86	99.55	100.05	99.97	99.50	99.94
FeOT (wt.%)	7.50	7.59	7.83	8.09	7.70	8.15
LOI (wt.%)	0.06	0.11	0.15	0.12	<0.01	0.15
Fe3+/Fe2+	0.7	0.7	0.7	0.7	0.6	0.5
Sc (ppm)	27.2	19.8	16.9	14.42	16.8	14.72
Cr	84.2	40.1	36.3	3.4	28.0	15.4
Co	30.4	29.3	28.0	na	27.9	29.2
V	263	259	263	269	256	270
Ni	40	30	26	22	28	25
Zn	73.9	81	80	81	80	79
Cu	129	135	112	161	146	126
W	5.1	5.6	5.8	na	6.2	5.7
Mo	3.6	4.3	3.9	3.2	3.7	5.5
Sb	0.384	0.34	0.44	0.43	0.34	0.292
As	7.7	6.9	6.7	10.8	7.5	5.7
Li	15	16	17	18	17	17
Be	6.4	7.0	7.8	9.1	7.5	7.4
Zr	204	211	196	214	213	208
Hf	4.70	4.75	5.08	5.23	4.74	5.00
Nb	27	33	31	22	30	33
Ta	1.67	1.79	1.88	na	1.82	1.92
Th	19.8	21.7	20.8	22.4	21.7	20.9
U	5.68	6.37	6.28	7.08	6.85	6.48
Rb	257	279	331	337	307	322
Cs	16.7	18.3	20.5	19.7	20.5	17.9
Sr	884	936	1010	1010	945	1070
Ba	1860	1990	1940	1980	2000	2160
Pb	33	40	32	40	36	29
Y	28	28	29	30	29	30
La	50.7	54.7	50.8	53.3	53.7	53.8
Ce	101.8	108.7	100.4	104.9	104.3	106.1
Nd	49.2	49.8	46.7	48	45.3	49.8
Sm	10.90	11.10	10.55	11.05	10.70	11.13
Eu	2.46	2.46	2.35	2.46	2.44	2.47
Tb	1.06	1.06	1.032	1.16	1.018	1.07
Yb	2.08	2.27	2.30	2.19	2.17	2.34
Lu	0.291	0.304	0.294	0.313	0.291	0.299
Au (ppb)	<7	<6	<5	<5	153	<8

Table 2:

Sample no.	V45	V44	V46	V47	V52	V51
Date A.D.	1794	1794	1794	1794	1805	1805
Laboratory no.	W-255736	W-255761	W-255718	W-255717	W-246280	W-255735
Analysis code	a,c	a,c	a,c	a,c	b,d	a,c
SiO2 (wt.%)	48.7	48.8	48.3	48.4	48.0	47.9
TiO2	0.95	0.94	0.96	0.98	1.00	0.99
Al2O3	13.3	13.7	15.0	15.7	17.6	17.5
Fe2O3	2.79	3.20	4.55	5.72	3.64	4.05
FeO	4.8	4.5	3.5	2.6	4.7	4.3
MnO	0.13	0.13	0.14	0.14	0.15	0.15
MgO	7.66	7.45	6.14	5.70	4.08	4.01
CaO	13.3	13.0	11.7	11.2	9.28	9.16
Na2O	1.63	1.71	2.19	2.02	2.38	2.44
K2O	5.17	5.31	5.41	6.18	7.29	7.34
H2O+	0.55	0.46	0.81	0.56	0.44	0.30
H2O-	0.19	0.13	0.22	0.03	0.35	0.30
P2O5	0.75	0.76	0.81	0.82	0.90	0.90
CO2	0.04	<0.01	0.09	0.12	0.03	0.01
F	0.18	0.22	0.28	0.17	0.23	0.18
Cl	0.16	0.19	0.32	0.11	0.30	0.40
S	<0.01	0.01	0.02	<0.01	<0.01	0.02
-O=F,Cl,S	0.12	0.15	0.21	0.10	0.18	0.19
Total	100.18	100.36	100.23	100.35	100.19	99.76
FeOT (wt.%)	7.31	7.38	7.59	7.75	7.97	7.95
LOI (wt.%)	0.41	0.21	0.77	0.41	0.36	0.30
Fe3+/Fe2+	0.5	0.6	1.2	2.0	0.7	0.8
Sc (ppm)	41.2	41.2	34.3	29.4	15.22	16.0
Cr	202	198	149.0	104.8	23.5	23.4
Co	31.4	32.0	30.4	30.2	na	28.1
V	270	269	275	278	261	271
Ni	59	58	48	41	25	25
Zn	70.9	69	78.8	82.4	74	78.8
Cu	95	101	101	119	111	128
W	4.7	3.5	4.6	5.1	na	6.6
Mo	3.3	5.2	3.2	2.7	2.1	3.9
Sb	0.25	0.26	0.29	0.339	0.343	0.385
As	4.6	4.6	5.7	8.8	7.6	8.0
Li	12	12	13	14	17	18
Be	5.7	5.9	6.7	7.3	8.5	8.1
Zr	165	165	184	184	207	204
Hf	4.30	4.52	4.66	4.88	4.75	5.07
Nb	20	22	23	25	21	30
Ta	1.20	1.27	1.38	1.54	na	1.83
Th	14.23	15.08	16.5	18.1	20.1	21.2
U	4.49	4.67	5.10	5.89	6.51	6.51
Rb	231	243	264	285	314	323
Cs	13.7	14.03	15.25	16.8	18.5	20.2
Sr	708	719	839	841	1020	1020
Ba	1490	1530	1730	1780	1980	2030
Pb	21	21	27	29	32	33
Y	26	27	28	29	28	30
La	36.3	38.5	40.9	45.0	51.0	51.4
Ce	74.5	78.9	83.3	89.1	97.3	100.6
Nd	34.2	40	38.1	42.2	44.3	43.4
Sm	9.30	9.80	9.84	10.37	10.61	10.67
Eu	2.06	2.16	2.19	2.29	2.25	2.43
Tb	0.924	0.987	0.958	1.021	1.09	1.06
Yb	1.85	2.03	1.93	2.15	2.09	2.25
Lu	0.250	0.262	0.270	0.283	0.315	0.302
Au (ppb)	<6	<9	<7	7	<5	<4

Table 2:

Sample no.	V50	V49	V53	V55	V56	V57
Date A.D.	1805	1805	1806	1806	1806	1806
Laboratory no.	W-246278	W-254030	W-255716	W-254033	W-246284	W-255698
Analysis code	b,d	b,d	a,c	b,d	b,d	a,c
SiO2 (wt.%)	48.0	48.0	47.9	48.0	48.0	47.9
TiO2	0.99	1.01	1.00	1.01	0.99	0.99
Al2O3	17.5	17.7	17.4	17.4	17.5	17.6
Fe2O3	3.43	3.75	3.37	4.39	3.40	3.91
FeO	4.9	4.6	4.9	4.0	4.9	4.4
MnO	0.15	0.15	0.15	0.15	0.15	0.15
MgO	3.99	3.98	4.29	4.23	4.08	4.03
CaO	9.19	9.14	9.54	9.48	9.28	9.21
Na2O	2.48	2.29	2.32	2.22	2.48	2.44
K2O	7.36	7.39	7.15	7.14	7.29	7.36
H2O+	0.16	0.66	0.35	0.29	0.39	0.46
H2O-	0.37	0.26	0.25	0.57	0.28	0.21
P2O5	0.90	0.89	0.91	0.90	0.88	0.89
CO2	0.01	0.02	0.01	0.01	0.01	0.01
F	0.21	na	0.23	na	0.21	0.25
Cl	0.40	na	0.29	na	0.43	0.48
S	<0.01	na	<0.01	na	<0.01	0.03
-O=F,Cl,S	0.19	na	0.17	na	0.20	0.25
Total	99.85	99.84	99.89	99.79	100.07	100.08
FeOT (wt.%)	7.99	7.97	7.94	7.95	7.96	7.92
LOI (wt.%)	0.09	0.46	0.30	0.45	0.18	0.16
Fe3+/Fe2+	0.6	0.7	0.6	1.0	0.6	0.8
Sc (ppm)	15.02	15.38	18.3	16.8	15.11	16.2
Cr	19.7	19.9	28.9	25.8	21.6	24.6
Co	na	na	29.8	na	na	28.2
V	219	219	275	232	222	249
Ni	21	21	28	25	21	25
Zn	76	82	84	76	77	78.3
Cu	121	119	120	125	113	122
W	na	na	4.1	na	na	6.7
Mo	4.2	<5	3.7	3.6	<7	3.6
Sb	0.31	0.41	0.407	0.43	0.387	0.37
As	8.5	8.4	7.1	8.7	6.2	8.7
Li	15	14	18	15	15	15
Be	7.4	7.6	8.0	7.8	7.6	7.7
Zr	205	212	212	206	201	212
Hf	4.82	5.20	5.27	4.81	4.83	5.02
Nb	24	30	29	25	21	32
Ta	na	na	1.86	na	na	1.83
Th	20.3	21.3	21.6	19.9	20.3	20.9
U	6.47	6.86	6.35	6.52	6.45	6.51
Rb	323	332	326	313	331	338
Cs	18.9	19.7	19.8	18.3	18.7	19.8
Sr	1030	1000	999	977	1030	1030
Ba	2040	2010	1970	1960	2030	2030
Pb	33	31	51	31	35	39
Y	26	26	30	28	27	29
La	52.0	53.2	52.6	50.7	51.3	51.8
Ce	98.5	104.6	106.2	99.0	98.2	101.8
Nd	45.3	48.7	49.9	46.3	46.2	49.2
Sm	10.72	11.11	11.26	10.82	10.58	10.68
Eu	2.36	2.44	2.52	2.39	2.27	2.41
Tb	1.13	1.18	1.13	0.998	1.08	1.043
Yb	2.25	2.44	2.32	2.27	2.11	2.29
Lu	0.306	0.306	0.301	0.291	0.298	0.297
Au (ppb)	<6	<1	<6	<3	<6	<8

Table 2:

Sample no.	V54	V60	V58	V59	V63	V61
Date A.D.	1806	1822	1822	1822	1834	1834
Laboratory no.	W-254032	W-255750	W-255697	W-255754	W-254037	W-254036
Analysis code	b,d	a,c	a,c	a,c	b,d	b,d
SiO2 (wt.%)	47.7	48.3	48.3	48.4	47.8	47.8
TiO2	1.00	0.93	0.99	0.98	1.04	1.05
Al2O3	18.1	17.3	17.2	17.5	15.2	15.5
Fe2O3	3.43	3.41	2.39	2.45	3.90	2.75
FeO	4.9	4.3	5.6	5.5	4.2	5.3
MnO	0.16	0.14	0.15	0.15	0.14	0.14
MgO	3.64	4.51	4.49	4.23	6.11	5.92
CaO	9.18	9.34	9.18	8.81	12.0	11.8
Na2O	2.60	1.73	2.42	2.43	2.12	2.19
K2O	7.33	8.08	7.26	7.52	5.93	6.06
H2O+	0.50	0.26	0.50	0.61	0.03	0.24
H2O-	0.33	0.55	0.22	0.28	0.39	0.48
P2O5	0.83	0.87	0.93	0.95	0.83	0.85
CO2	0.01	0.01	0.01	0.01	0.01	0.01
F	na	0.080	0.30	0.19	0.16	na
Cl	na	0.04	0.29	0.23	0.33	na
S	na	<0.01	0.02	<0.01	0.01	na
-O=F,Cl,S	na	0.04	0.21	0.14	0.16	na
Total	99.71	99.81	100.04	100.10	100.04	100.09
FeOT (wt.%)	7.99	7.37	7.75	7.70	7.71	7.77
LOI (wt.%)	0.34	0.25	0.12	0.21	0.04	<0.01
Fe3+/Fe2+	0.6	0.7	0.4	0.4	0.8	0.5
Sc (ppm)	13.91	18.1	17.6	17.4	28.9	27.6
Cr	16.0	44.0	28.1	30.4	108.0	100.3
Co	na	27.6	28.1	27.6	na	na
V	229	218	217	224	243	235
Ni	16	28	26	26	43	39
Zn	80	77	76.5	77	73	77
Cu	124	49	128	123	109	102
W	na	4.9	5.9	5.6	na	na
Mo	3.0	3.6	4.8	4.6	4.2	<6
Sb	0.36	0.36	0.37	0.42	0.292	0.33
As	7.5	4.6	9.7	9.3	6.2	4.8
Li	15	7.1	12	12	12	12
Be	7.6	7.2	7.0	7.2	6.4	6.2
Zr	209	199	193	202	179	175
Hf	4.97	4.72	4.83	4.65	4.54	4.65
Nb	28	35	31	31	19	17
Ta	na	1.97	1.79	1.79	na	na
Th	21.5	24.3	21.7	21.0	16.2	16.6
U	6.41	7.57	6.65	7.04	5.19	5.28
Rb	305	319	342	367	269	256
Cs	17.6	18.1	22.2	21.9	13.5	14.1
Sr	1120	1010	928	947	894	855
Ba	2090	2130	2010	2030	1700	1740
Pb	30	23	36	39	25	24
Y	28	27	25	26	26	25
La	55.8	57.5	51.5	50.7	43.0	43.7
Ce	109.6	112.3	102.8	99.8	86.1	87.5
Nd	49.2	46.8	48.3	44.4	42.0	42.6
Sm	11.31	10.95	10.59	10.42	10.10	10.23
Eu	2.51	2.43	2.37	2.32	2.19	2.25
Tb	1.09	1.047	1.026	0.991	0.976	0.969
Yb	2.32	2.23	2.16	2.22	2.05	2.05
Lu	0.319	0.298	0.297	0.282	0.269	0.270
Au (ppb)	<9	<6	<8	<8	<5	<6

Table 2:

Sample no.	V62	V64	V65	V68	V67	V66
Date A.D.	1834	1834	1839	1839	1839	1839
Laboratory no.	W-255749	W-255724	W-254038	W-255722	W-255723	W-255752
Analysis code	a,c	a,c	b,d	a,c	a,c	a,c
SiO2 (wt.%)	47.8	47.9	47.5	47.9	47.4	47.4
TiO2	1.02	0.97	1.05	0.99	1.04	1.03
Al2O3	17.6	18.6	17.2	17.5	17.6	17.7
Fe2O3	3.24	2.32	2.76	4.59	4.62	3.86
FeO	5.0	5.6	5.5	3.8	3.8	4.5
MnO	0.15	0.15	0.15	0.15	0.15	0.15
MgO	4.14	3.23	4.41	4.13	4.06	3.99
CaO	9.32	8.24	10.1	9.38	9.60	9.44
Na2O	2.58	2.67	2.37	2.30	2.58	2.62
K2O	7.22	8.00	6.93	7.29	7.16	7.21
H2O+	0.03	0.30	0.18	0.36	0.33	0.34
H2O-	0.42	0.63	0.51	0.31	0.30	0.34
P2O5	0.88	0.81	0.89	0.89	0.89	0.89
CO2	0.01	0.01	0.01	0.02	0.01	0.01
F	0.19	0.21	na	0.19	0.21	0.23
Cl	0.50	0.26	na	0.36	0.40	0.46
S	<0.01	<0.01	na	<0.01	<0.01	<0.05
-O=F,Cl,S	0.21	0.16	na	0.18	0.19	0.22
Total	99.89	99.74	99.56	99.98	99.95	99.95
FeOT (wt.%)	7.92	7.68	7.98	7.93	7.95	7.97
LOI (wt.%)	<0.01	0.21	0.22	0.22	0.16	0.09
Fe3+/Fe2+	0.6	0.4	0.5	1.1	1.1	0.8
Sc (ppm)	17.0	10.28	18.3	16.2	16.8	15.36
Cr	26.7	10.5	31.2	22.7	26.3	19.7
Co	28.2	25.7	na	28.3	28.2	28.3
V	237	222	239	262	243	243
Ni	24	16	25	26	24	21
Zn	77	82	76.6	83	82	78
Cu	133	117	119	112	118	133
W	4.9	4.8	na	5.6	7.0	6.6
Mo	3.9	<8	<4	3.2	3.3	<7
Sb	0.35	0.39	0.33	0.37	0.353	0.444
As	8.3	8.4	5.7	8.3	9.2	10.4
Li	14	15	15	16	14	14
Be	7.2	8.0	7.6	8.2	7.2	7.4
Zr	184	200	200	203	200	188
Hf	4.48	4.58	4.66	5.03	4.75	4.85
Nb	30	33	24	30	30	32
Ta	1.76	2.02	na	1.79	1.85	1.89
Th	18.8	21.2	19.3	21.0	19.4	19.9
U	5.96	6.91	6.23	6.47	6.63	6.56
Rb	321	366	307	327	305	304
Cs	17.5	20.9	16.2	19.8	16.6	17.0
Sr	1020	1080	1010	1030	1020	1030
Ba	2000	2140	1980	1960	1990	2020
Pb	30	36	28	33	32	35
Y	26	27	27	30	27	27
La	46.6	51.0	48.6	52.0	49.2	50.7
Ce	91.5	98.6	95.2	103.0	95.2	97.8
Nd	39.9	43.3	47.9	44	42.8	43.5
Sm	9.77	9.89	10.64	10.65	10.21	10.51
Eu	2.16	2.24	2.36	2.42	2.31	2.38
Tb	0.964	0.936	1.028	1.050	1.001	1.035
Yb	2.11	2.24	2.24	2.22	2.19	2.26
Lu	0.287	0.291	0.291	0.306	0.294	0.298
Au (ppb)	<7	<5	<6	11	<6	6

Table 2:

Sample no.	V72	V71	V70	V77	V73	V74
Date A.D.	1850	1850	1850	1855	1855	1855
Laboratory no.	W-246300	W-246299	W-255730	W-255700	W-246364	W-255729
Analysis code	b,d	b,d	a,c	a,c	b,d	a,c
SiO2 (wt.%)	47.6	47.9	48.0	47.5	47.7	47.5
TiO2	1.01	1.00	1.01	1.03	1.04	1.03
Al2O3	16.2	17.4	18.6	16.3	16.3	16.5
Fe2O3	4.37	6.03	4.63	3.12	3.03	2.84
FeO	3.9	2.5	3.7	5.0	5.1	5.3
MnO	0.15	0.15	0.15	0.15	0.15	0.15
MgO	5.31	4.29	3.47	5.27	5.20	5.11
CaO	11.2	9.48	8.02	10.9	10.9	10.8
Na2O	2.19	2.21	2.62	2.43	2.50	2.46
K2O	6.29	7.12	7.76	6.46	6.46	6.50
H2O+	0.16	0.13	0.17	0.19	0.33	0.08
H2O-	0.56	0.58	0.63	0.59	0.14	0.39
P2O5	0.83	0.90	0.84	0.84	0.83	0.84
CO2	0.03	<0.01	0.01	0.02	0.03	0.01
F	0.21	0.23	0.31	0.24	0.19	0.23
Cl	0.29	0.12	0.37	0.42	0.45	0.40
S	<0.01	<0.01	0.03	0.03	<0.01	<0.01
-O=F,Cl,S	0.17	0.13	0.24	0.23	0.20	0.20
Total	100.13	99.91	100.07	100.27	100.15	99.94
FeOT (wt.%)	7.83	7.93	7.86	7.81	7.83	7.86
LOI (wt.%)	0.34	0.40	0.35	0.29	0.06	0.05
Fe3+/Fe2+	1.0	2.2	1.1	0.6	0.5	0.5
Sc (ppm)	23.7	17.3	15.36	22.3	21.3	23.4
Cr	78.8	26.9	27.2	72.2	74.6	84.8
Co	na	na	27.6	29.6	na	30.2
V	254	263	267	272	255	265
Ni	37	28	21	35	36	34
Zn	72.2	77.4	82	80	75.6	84
Cu	119	118	124	104	122	110
W	na	na	4.9	5.9	na	4.7
Mo	<5	4.0	3.4	<5	3.9	<8
Sb	0.28	0.36	0.380	0.33	0.29	0.33
As	7.1	11.0	7.7	5.7	7.0	8.4
Li	14	17	15	14	15	14
Be	7.2	8.5	7.9	7.2	7.6	7.2
Zr	203	209	203	202	210	202
Hf	4.83	4.99	5.06	5.02	4.86	5.17
Nb	22	24	34	31	26	32
Ta	na	na	1.98	1.83	na	1.86
Th	18.0	20.4	21.1	19.7	18.9	20.0
U	5.62	6.55	6.15	6.01	5.82	6.12
Rb	267	328	355	275	276	283
Cs	14.5	18.9	17.6	15.9	15.0	15.62
Sr	987	978	1020	992	987	1030
Ba	1860	1990	2140	1790	1830	1870
Pb	26	30	32	250	26	61
Y	29	29	31	31	30	30
La	48.6	50.7	55.2	53.1	50.8	53.1
Ce	96.2	100.8	104.4	105.0	100.5	102.7
Nd	45.0	45.6	45.3	50	45.8	45.6
Sm	10.50	10.76	10.77	11.20	10.50	11.24
Eu	2.34	2.37	2.46	2.45	2.30	2.48
Tb	1.15	1.14	1.051	1.10	1.14	1.11
Yb	2.24	2.18	2.31	2.32	2.31	2.26
Lu	0.299	0.309	0.314	0.308	0.296	0.305
Au (ppb)	<6	<6	11	<9	<8	<8

Table 2:

Sample no.	V75	V78	V80	V81	V79	V84
Date A.D.	1855	1855	1858	1858	1858	1861
Laboratory no.	W-255704	W-255699	W-255705	W-246366	W-246307	W-255701
Analysis code	a,c	a,c	a,c	b,d	b,d	a,c
SiO2 (wt.%)	47.3	47.6	47.6	47.7	47.5	47.9
TiO2	1.04	1.00	1.08	1.08	1.06	1.00
Al2O3	16.8	18.7	17.6	17.7	17.8	17.1
Fe2O3	5.32	5.01	2.08	2.35	2.36	3.24
FeO	3.1	3.5	6.2	5.9	5.9	5.0
MnO	0.15	0.16	0.15	0.15	0.15	0.15
MgO	4.72	3.20	4.20	4.05	3.99	4.27
CaO	10.3	8.54	9.20	9.06	8.92	9.63
Na2O	2.42	2.66	2.65	2.71	2.60	2.40
K2O	6.69	7.62	7.27	7.39	7.38	7.20
H2O+	0.34	0.33	0.34	0.29	0.60	0.16
H2O-	0.40	0.39	0.11	0.01	0.40	0.21
P2O5	0.84	0.82	0.99	0.99	1.00	0.89
CO2	0.05	0.03	0.03	0.01	0.02	0.02
F	0.20	0.23	0.33	0.23	0.25	0.18
Cl	0.47	0.26	0.27	0.28	0.19	0.29
S	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.21	0.17	0.22	0.17	0.16	0.15
Total	99.94	99.88	99.90	99.73	99.97	99.49
FeOT (wt.%)	7.89	8.01	8.07	8.02	8.03	7.92
LOI (wt.%)	0.35	0.53	0.07	<0.01	0.34	0.25
Fe3+/Fe2+	1.5	1.3	0.3	0.4	0.4	0.6
Sc (ppm)	21.9	10.55	14.45	13.83	12.99	18.9
Cr	70.8	6.3	17.1	16.9	14.7	34.7
Co	30.2	26.3	28.9	na	na	29.3
V	267	255	265	243	248	236
Ni	33	15	27	25	24	23
Zn	82	83	81	75	76.1	79
Cu	115	133	120	125	114	130
W	6.3	5.9	6.5	na	na	5.6
Mo	6.1	6.2	3.8	<8	6.0	4.3
Sb	0.40	0.36	0.372	0.38	0.32	0.30
As	8.4	9.7	9.3	6.1	7.0	7.7
Li	14	13	15	16	15	13
Be	7.4	8.1	8.1	8.2	7.5	7.1
Zr	209	217	228	206	213	204
Hf	5.24	4.97	5.08	4.88	4.82	5.10
Nb	31	37	33	22	28	31
Ta	1.87	2.10	1.95	na	na	1.80
Th	20.8	22.2	21.7	20.9	20.5	21.0
U	6.13	6.60	6.62	6.53	6.57	6.17
Rb	290	332	320	327	322	312
Cs	16.6	19.7	18.3	17.4	17.7	19.5
Sr	1020	1150	1070	1050	1050	949
Ba	1890	2200	2100	2100	2070	1970
Pb	34	33	30	27	30	34
Y	31	30	31	29	28	27
La	54.3	57.1	55.1	54.2	53.7	51.0
Ce	109.3	111.2	109.8	105.1	105.1	103.0
Nd	53	49.9	52.1	47.8	47.6	47.1
Sm	11.52	10.88	11.31	11.17	10.83	10.90
Eu	2.54	2.41	2.51	2.44	2.34	2.48
Tb	1.12	1.06	1.08	1.16	1.15	1.10
Yb	2.38	2.39	2.23	2.05	2.27	2.33
Lu	0.322	0.319	0.302	0.304	0.295	0.312
Au (ppb)	7	<6	<6	<7	<5	<4

Table 2:

Sample no.	V86	V87a	V88	V91	V92	V93
Date A.D.	1867	1868	1871-1872	1872	1872	1881
Laboratory no.	W-246371	W-246373	W-255694	W-255748	W-255715	W-255712
Analysis code	b,d	b,c	a,c	a,c	a,c	a,c
SiO2 (wt.%)	47.9	48.0	47.4	47.5	47.0	48.1
TiO2	1.00	0.99	1.07	1.04	1.03	0.93
Al2O3	16.9	17.7	18.4	16.3	18.4	18.0
Fe2O3	3.22	2.96	3.10	6.61	5.00	2.15
FeO	5.2	5.0	5.4	1.9	3.6	5.8
MnO	0.15	0.15	0.16	0.15	0.16	0.15
MgO	4.63	3.95	3.44	5.14	3.46	3.84
CaO	10.3	8.74	8.70	10.9	8.69	8.99
Na2O	2.32	2.67	2.83	2.36	2.82	2.52
K2O	6.75	7.74	7.50	6.29	7.44	7.53
H2O+	0.24	0.24	0.32	0.24	0.13	0.34
H2O-	0.09	0.09	0.10	0.09	0.09	0.08
P2O5	0.88	0.87	0.86	0.84	0.85	0.93
CO2	0.02	0.03	0.02	0.07	0.02	0.01
F	0.27	0.23	0.16	0.20	0.22	0.14
Cl	0.26	0.42	0.36	0.29	0.51	0.27
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.18	0.21	0.16	0.16	0.23	0.13
Total	99.95	99.57	99.66	99.76	99.19	99.65
FeOT (wt.%)	8.10	7.67	8.19	7.85	8.10	7.74
LOI (wt.%)	<0.01	0.24	0.34	0.45	0.04	0.12
Fe3+/Fe2+	0.6	0.5	0.5	3.1	1.2	0.3
Sc (ppm)	20.43	13.04	10.62	23.6	10.97	14.20
Cr	26.7	27.1	6.7	80.8	7.8	16.8
Co	na	na	28.1	30.1	28.5	27.1
V	245	138	265	256	255	230
Ni	24	14	18	35	17	23
Zn	74	75	83	77	83	78.2
Cu	121	136	134	97	143	117
W	na	na	6.0	<5	7.3	5.0
Mo	3.7	<4	4.6	3.5	5.1	<8
Sb	0.180	0.32	0.43	0.36	0.44	0.40
As	6.4	7.1	10.4	7.5	9.6	6.8
Li	12	9.3	16	15	15	15
Be	6.5	4.7	8.5	7.4	7.8	7.6
Zr	193	203	228	213	233	199
Hf	4.22	4.21	5.39	5.20	5.32	4.29
Nb	25	33	37	31	30	30
Ta	na	na	2.10	1.82	2.16	1.79
Th	15.6	19.2	23.4	19.9	23.6	19.0
U	4.80	6.70	7.07	6.09	7.46	5.42
Rb	267	367	334	269	337	292
Cs	13.7	18.8	20.1	15.9	18.8	18.5
Sr	969	1060	1130	986	1140	1080
Ba	2190	2160	2110	1840	2110	2440
Pb	24	33	36	33	38	28
Y	27	16	32	31	30	29
La	43.4	47.6	59.6	52.8	60.3	51.0
Ce	86.8	93.2	116.5	106.0	117.0	100.5
Nd	42.0	43.2	50.9	49.6	53.1	45.9
Sm	9.57	9.53	11.45	11.19	11.58	9.93
Eu	2.10	2.05	2.58	2.48	2.56	2.24
Tb	1.02	0.98	1.12	1.10	1.10	0.996
Yb	2.11	1.89	2.41	2.31	2.40	2.17
Lu	0.291	0.278	0.326	0.315	0.336	0.296
Au (ppb)	<7	8	<4	<8	<8	6

Table 2:

Sample no.	V95	V96	V97	V98	V100	V108
Date A.D.	1883-1906	1886	1891-1894	1891-1894	1895-1899	1906
Laboratory no.	W-246381	W-246382	W-246383	W-246384	W-246386	W-255711
Analysis code	b,d	b,d	b,d	b,d	b,d	a,c
SiO2 (wt.%)	47.8	47.9	48.2	47.8	47.6	47.7
TiO2	1.01	1.01	0.92	1.00	1.00	1.01
Al2O3	16.3	17.4	18.0	18.6	18.5	15.7
Fe2O3	2.90	4.18	2.65	3.72	6.09	2.39
FeO	5.2	4.2	5.2	4.6	2.5	5.6
MnO	0.15	0.15	0.15	0.16	0.16	0.15
MgO	5.13	4.08	3.78	3.19	3.11	5.63
CaO	11.0	9.36	9.00	8.58	8.65	11.5
Na2O	2.31	2.53	2.59	2.79	2.74	2.23
K2O	6.43	7.34	7.53	7.64	7.61	6.11
H2O+	0.33	0.24	0.32	0.34	0.25	0.39
H2O-	0.12	0.09	0.10	0.04	0.10	0.14
P2O5	0.83	0.90	0.89	0.82	0.85	0.83
CO2	0.02	0.02	0.01	0.03	0.08	0.02
F	0.19	0.26	0.11	0.18	0.23	0.19
Cl	0.35	0.47	0.29	0.34	0.31	0.34
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.17	0.23	0.12	0.17	0.18	0.17
Total	99.90	99.90	99.62	99.66	99.60	99.76
FeOT (wt.%)	7.81	7.96	7.59	7.95	7.98	7.75
LOI (wt.%)	0.18	0.15	0.20	0.23	0.42	0.45
Fe3+/Fe2+	0.5	0.9	0.5	0.7	2.2	0.4
Sc (ppm)	23.2	15.70	14.09	10.67	10.59	28.5
Cr	79.5	21.1	19.1	5.9	4.0	113
Co	na	na	na	na	na	31.8
V	318	263	213	245	238	269
Ni	40	24	22	16	13	43
Zn	78	74	72	75	80	76.5
Cu	125	126	121	136	154	126
W	na	na	na	na	na	3.6
Mo	3.1	<4	2.9	2.8	2.8	4.5
Sb	0.34	0.37	0.342	0.377	0.386	0.28
As	5.8	7.4	7.9	6.8	9.5	7.1
Li	16	17	15	17	18	14
Be	8.3	7.9	7.9	8.9	9.1	6.9
Zr	206	214	200	219	228	202
Hf	4.77	4.92	4.20	5.01	5.03	4.99
Nb	16	23	31	30	30	27
Ta	na	na	na	na	na	1.71
Th	18.4	20.2	19.1	22.3	23.1	18.2
U	5.28	6.39	5.75	6.73	7.60	5.37
Rb	255	322	306	335	327	256
Cs	15.0	19.0	15.9	18.9	17.1	14.9
Sr	978	1010	1100	1160	1190	940
Ba	1880	2040	2370	2210	2210	1850
Pb	29	32	27	30	34	25
Y	36	30	28	31	31	28
La	49.0	50.5	51.5	56.5	58.9	48.7
Ce	98.7	99.1	98.8	110.6	110.9	99.3
Nd	45.1	44.2	43.4	47	48.5	47.4
Sm	10.41	10.42	9.63	10.81	11.08	10.83
Eu	2.30	2.31	2.17	2.47	2.41	2.47
Tb	1.18	1.18	1.06	1.20	1.19	1.073
Yb	2.23	2.21	2.15	2.25	2.46	2.37
Lu	0.297	0.285	0.281	0.327	0.332	0.303
Au (ppb)	<7	<4	<4	<4	<4	<6

Table 2:

Sample no.	V107	V105	V111	V115	V118	V116
Date A.D.	1906	1906	1913-1944	1929	1929	1929
Laboratory no.	W-255714	W-246390	W-255745	W-255744	W-246403	W-255743
Analysis code	a,c	b,d	a,c	a,c	b,d	a,c
SiO2 (wt.%)	47.5	47.8	48.5	47.8	47.8	47.8
TiO2	1.02	1.02	0.93	1.02	1.00	1.00
Al2O3	17.4	18.2	17.6	16.5	16.6	16.6
Fe2O3	3.21	6.12	1.71	3.47	3.41	3.98
FeO	5.1	2.5	6.1	5.1	5.1	4.6
MnO	0.16	0.16	0.14	0.15	0.15	0.15
MgO	4.12	3.52	4.21	4.90	4.79	4.77
CaO	9.93	9.08	9.24	10.7	10.6	10.6
Na2O	2.59	2.56	2.39	2.24	2.30	2.28
K2O	6.95	7.13	7.47	6.49	6.53	6.47
H2O+	0.37	0.35	0.31	0.35	0.31	0.41
H2O-	0.04	0.12	0.11	0.08	0.08	0.08
P2O5	0.85	0.84	0.91	0.88	0.88	0.88
CO2	0.01	0.07	<0.01	0.01	0.01	0.02
F	0.23	0.18	0.18	0.22	0.17	0.15
Cl	0.44	0.25	0.24	0.19	0.27	0.28
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.21	0.14	0.14	0.14	0.14	0.14
Total	99.71	99.76	99.90	99.96	99.86	99.93
FeOT (wt.%)	7.99	8.01	7.64	8.22	8.17	8.18
LOI (wt.%)	0.20	0.45	0.10	0.06	<0.01	0.17
Fe3+/Fe2+	0.6	2.2	0.3	0.6	0.6	0.8
Sc (ppm)	18.7	12.57	16.5	23.8	22.25	23.0
Cr	31.9	9.9	23.5	32.2	30.7	31.0
Co	29.7	na	27.9	30.2	na	30.3
V	260	270	218	252	282	249
Ni	23	17	26	26	27	25
Zn	84	74.0	77	77	74.7	78
Cu	130	83	120	127	124	119
W	6.4	na	4.4	5.3	na	6.1
Mo	5.7	2.6	3.7	<4	2.8	3.7
Sb	0.33	0.38	0.357	0.36	0.296	0.328
As	8.5	8.7	6.7	6.7	5.9	6.7
Li	16	17	13	12	15	13
Be	7.7	8.4	7.1	6.7	7.0	6.7
Zr	224	228	185	190	183	195
Hf	5.22	4.83	4.21	4.57	4.43	4.59
Nb	32	29	30	28	24	28
Ta	1.99	na	1.66	1.57	na	1.60
Th	21.0	20.9	17.7	16.2	15.9	16.3
U	5.89	6.84	5.03	4.69	4.65	4.78
Rb	286	314	303	260	249	255
Cs	17.6	17.3	17.6	14.28	13.69	13.80
Sr	1090	1130	1020	969	970	992
Ba	2070	2210	2310	2190	2130	2200
Pb	39	29	27	24	24	22
Y	28	32	25	26	30	26
La	55.1	55.0	48.7	44.6	43.5	44.8
Ce	110.4	105.8	96.2	90.0	87.8	90.4
Nd	49	47	39.6	42.8	39.8	39.8
Sm	11.29	10.69	9.58	9.97	9.62	9.89
Eu	2.58	2.36	2.18	2.28	2.22	2.30
Tb	1.12	1.17	0.957	1.040	1.037	1.029
Yb	2.61	2.18	2.06	2.35	2.07	2.22
Lu	0.322	0.313	0.282	0.289	0.293	0.298
Au (ppb)	7	<9	<8	<7	<5	<6

Table 2:

Sample no.	V114	V119	V120	V121	V148	V133
Date A.D.	1929	1929	1941	1941	1944	1944
Laboratory no.	W-246399	W-255695	W-246567	W-246568	W-255734	W-255706
Analysis code	b,d	a,c	b,d	b,d	a,c	a,c
SiO2 (wt.%)	47.8	48.0	48.4	48.6	47.6	49.0
TiO2	1.00	0.98	0.88	0.90	0.96	0.91
Al2O3	16.8	18.6	18.4	18.7	14.5	18.0
Fe2O3	3.27	3.76	4.81	2.18	6.19	2.99
FeO	5.2	4.4	3.1	5.6	2.0	4.9
MnO	0.15	0.15	0.14	0.14	0.15	0.14
MgO	4.64	3.22	3.48	3.38	7.23	3.77
CaO	10.4	8.29	8.34	8.20	13.3	8.91
Na2O	2.31	2.73	2.64	2.63	1.63	2.63
K2O	6.65	7.89	7.85	8.10	4.79	7.59
H2O+	0.36	0.32	0.25	0.43	0.52	0.41
H2O-	0.05	0.10	0.20	0.07	0.38	0.09
P2O5	0.88	0.82	0.87	0.90	0.83	0.88
CO2	0.01	0.02	0.06	0.01	0.01	0.02
F	0.20	0.22	0.19	0.19	0.29	0.12
Cl	0.30	0.36	0.28	0.25	0.08	0.22
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-O=F,Cl,S	0.16	0.19	0.15	0.15	0.14	0.11
Total	99.86	99.67	99.74	100.13	100.31	100.48
FeOT (wt.%)	8.14	7.78	7.43	7.56	7.57	7.59
LOI (wt.%)	<0.01	0.20	0.26	<0.01	0.90	0.26
Fe3+/Fe2+	0.6	0.8	1.4	0.3	2.8	0.5
Sc (ppm)	22.1	10.56	11.80	11.07	35.1	14.92
Cr	29.8	10.8	16.4	9.5	146.4	21.3
Co	na	26.5	na	na	32.0	26.8
V	250	222	217	221	252	222
Ni	25	17	19	18	53	23
Zn	77.8	83.1	71	72.5	76.0	76.7
Cu	124	130	121	114	86	96
W	na	5.3	na	na	7.1	4.6
Mo	2.2	4.1	2.4	<4	<6	6.9
Sb	0.33	0.407	0.372	0.31	0.32	0.39
As	5.6	8.9	7.4	8.2	6.5	7.8
Li	13	17	16	16	11	15
Be	7.1	8.5	7.5	7.8	5.8	7.9
Zr	190	214	191	194	180	193
Hf	4.39	4.61	4.03	3.89	4.72	4.30
Nb	21	36	30	26	22	31
Ta	na	1.99	na	na	1.36	1.79
Th	16.1	21.3	19.4	19.3	14.5	19.8
U	4.64	6.77	5.97	5.71	4.33	5.55
Rb	240	361	319	308	191	293
Cs	13.8	21.0	18.0	17.8	11.4	17.7
Sr	960	1080	1070	1080	836	1080
Ba	2170	2170	2350	2380	1690	2370
Pb	25	31	29	30	28	22
Y	28	26	27	28	26	27
La	44.0	50.3	51.3	51.2	44.0	52.7
Ce	88.8	98.2	99.9	99.1	89.3	103.0
Nd	40.3	44	40.5	42.6	42.8	46.2
Sm	9.72	9.68	9.33	9.35	10.44	9.83
Eu	2.22	2.25	2.13	2.16	2.34	2.30
Tb	1.017	0.948	1.10	0.975	1.042	0.989
Yb	2.19	2.20	2.18	2.09	2.12	2.16
Lu	0.291	0.298	0.294	0.268	0.301	0.298
Au (ppb)	<5	<7	<4	<4	<5	<4

Table 2:

Sample no.	V149	V143	V130	V125	V137	V141
Date A.D.	1944	1944	1944	1944	1944	1944
Laboratory no.	W-246596	W-255733	W-246577	W-255702	W-255728	W-246588
Analysis code	b,d	a,c	b,d	a,c	a,c	b,d
SiO2 (wt.%)	47.9	48.3	48.4	48.4	48.2	48.3
TiO2	0.90	0.89	0.91	0.89	0.91	0.90
Al2O3	18.0	18.2	18.3	18.3	18.3	18.4
Fe2O3	4.60	2.27	2.84	3.66	4.27	2.22
FeO	3.4	5.4	5.0	4.2	3.7	5.5
MnO	0.14	0.14	0.15	0.14	0.14	0.14
MgO	3.77	3.66	3.65	3.64	3.57	3.52
CaO	8.94	8.72	8.72	8.59	8.60	8.48
Na2O	2.62	2.57	2.58	2.57	2.71	2.63
K2O	7.48	7.82	7.75	7.80	7.78	7.89
H2O+	0.33	0.28	0.23	0.38	0.24	0.39
H2O-	0.11	0.10	0.07	0.07	0.46	0.04
P2O5	0.88	0.87	0.89	0.87	0.88	0.88
CO2	<0.01	0.01	0.02	<0.01	0.03	0.01
F	0.15	0.16	0.16	0.23	0.20	0.19
Cl	0.34	0.22	0.20	0.22	0.28	0.21
S	<0.01	0.02	<0.01	0.02	<0.01	<0.01
-O=F,Cl,S	0.15	0.13	0.12	0.16	0.16	0.14
Total	99.41	99.49	99.75	99.82	100.11	99.56
FeOT (wt.%)	7.54	7.44	7.56	7.50	7.54	7.50
LOI (wt.%)	0.30	0.07	0.04	0.16	<0.01	0.06
Fe3+/Fe2+	1.2	0.4	0.5	0.8	1.0	0.4
Sc (ppm)	13.94	13.7	13.49	13.98	11.66	12.53
Cr	20.7	18.8	17.5	18.1	15.7	16.0
Co	na	26.3	na	26.7	24.6	na
V	210	221	206	217	205	209
Ni	22	23	21	22	21	22
Zn	78.2	78.8	72.2	77.5	76.6	72.6
Cu	114	117	116	123	105	122
W	na	5.2	na	6.3	6.1	na
Mo	<4	4.5	4.5	5.5	2.6	3.7
Sb	0.353	0.375	0.39	0.416	0.37	0.360
As	8.2	8.4	8.3	9.3	5.8	6.9
Li	15	15	15	13	15	15
Be	7.6	7.5	7.8	8.0	7.9	8.2
Zr	191	198	203	197	189	196
Hf	4.32	4.31	4.28	4.37	3.96	4.05
Nb	24	32	34	34	33	27
Ta	na	1.80	na	1.85	1.79	na
Th	19.2	19.8	19.5	20.3	19.0	19.8
U	5.67	5.86	5.89	5.95	6.09	5.76
Rb	295	298	310	311	321	305
Cs	16.6	17.6	16.7	17.8	17.6	17.3
Sr	1060	1050	1090	1070	1090	1090
Ba	2350	2320	2390	2350	2380	2410
Pb	25	28	27	28	29	28
Y	26	27	27	27	26	28
La	52.1	52.6	52.2	54.0	52.1	51.5
Ce	101.3	102.8	100.9	105.3	97.0	100.8
Nd	44.1	43.3	43	47.6	40.5	43.0
Sm	9.68	9.95	9.69	10.00	9.59	9.51
Eu	2.23	2.27	2.20	2.32	2.11	2.19
Tb	1.06	0.965	1.02	0.992	0.899	1.01
Yb	2.12	2.22	2.16	2.23	2.02	1.96
Lu	0.317	0.295	0.285	0.304	0.286	0.287
Au (ppb)	<7	<4	<4	<4	<5	<4

Table 2:

Sample no.	V124	V136	V122	V146	V145	V127
Date A.D.	1944	1944	1944	1944	1944	1944
Laboratory no.	W-246571	W-246583	W-246569	W-255746	W-246592	W-255703
Analysis code	b,d	b,d	b,d	a,c	b,d	a,c
SiO2 (wt.%)	48.3	48.1	48.5	48.3	48.4	48.3
TiO2	0.90	0.89	0.89	0.89	0.87	0.88
Al2O3	18.5	18.4	18.5	18.4	18.5	18.6
Fe2O3	3.30	4.39	3.56	2.55	2.68	6.21
FeO	4.5	3.5	4.3	5.2	4.9	1.8
MnO	0.14	0.14	0.14	0.14	0.14	0.14
MgO	3.49	3.46	3.45	3.43	3.43	3.37
CaO	8.33	8.36	8.27	8.35	8.32	8.20
Na2O	2.62	2.59	2.55	2.61	2.51	2.54
K2O	7.89	7.77	7.93	7.95	8.14	7.88
H2O+	0.27	0.36	0.40	0.27	0.35	0.29
H2O-	0.12	0.09	0.12	0.08	0.21	0.05
P2O5	0.87	0.88	0.88	0.88	0.85	0.87
CO2	0.01	0.06	0.01	0.01	0.05	0.11
F	0.19	0.11	0.18	0.27	0.19	0.19
Cl	0.23	0.17	0.24	0.22	0.25	0.16
S	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
-O=F,Cl,S	0.14	0.09	0.14	0.18	0.15	0.12
Total	99.52	99.18	99.78	99.39	99.65	99.47
FeOT (wt.%)	7.47	7.45	7.50	7.50	7.32	7.39
LOI (wt.%)	0.21	0.48	0.11	0.08	0.31	0.34
Fe3+/Fe2+	0.7	1.1	0.7	0.4	0.5	3.1
Sc (ppm)	12.32	12.08	11.90	12.73	12.02	12.20
Cr	17.5	16.1	16.8	17.9	15.6	17.7
Co	na	na	na	26.0	na	25.7
V	210	201	200	206	194	194
Ni	20	20	20	22	20	20
Zn	70.2	70.5	74.9	78	66.6	77.6
Cu	98	117	127	122	121	124
W	na	na	na	5.8	na	4.8
Mo	3.3	2.5	4.2	3.9	3.8	6.0
Sb	0.40	0.32	0.40	0.363	0.37	0.450
As	8.3	7.9	8.3	7.8	8.4	9.6
Li	15	15	14	14	12	15
Be	7.5	8.0	8.0	7.9	7.7	7.7
Zr	196	196	199	189	196	191
Hf	3.94	4.05	4.14	4.13	4.03	4.20
Nb	30	30	32	33	29	34
Ta	na	na	na	1.83	na	1.86
Th	19.6	19.2	19.8	19.8	18.7	20.2
U	5.91	5.88	5.85	5.97	5.56	6.17
Rb	305	307	323	300	321	334
Cs	17.5	17.0	17.5	18.6	17.8	18.3
Sr	1100	1100	1110	1100	1080	1100
Ba	2350	2400	2370	2450	2380	2420
Pb	30	27	30	29	28	29
Y	27	27	27	26	26	25
La	52.0	51.2	52.3	53.2	49.9	53.8
Ce	100.7	98.7	101.0	102.3	95.4	103.9
Nd	40	43.1	44	42	42.7	49.1
Sm	9.54	9.26	9.58	9.65	9.05	9.79
Eu	2.16	2.13	2.17	2.17	2.04	2.22
Tb	0.99	0.97	0.98	0.946	0.92	0.971
Yb	2.11	2.08	2.14	2.09	1.99	2.07
Lu	0.287	0.281	0.299	0.285	0.277	0.287
Au (ppb)	<1	<4	<6	<7	<4	<8

Table 2:

Sample no.	V132
Date A.D.	1944
Laboratory no.	W-255707
Analysis code	a,c
SiO2 (wt.%)	48.4
TiO2	0.90
Al2O3	18.5
Fe2O3	1.84
FeO	5.9
MnO	0.14
MgO	3.29
CaO	8.39
Na2O	2.67
K2O	8.01
H2O+	0.35
H2O-	0.04
P2O5	0.90
CO2	0.01
F	0.12
Cl	0.29
S	<0.01
-O=F,Cl,S	0.13
Total	99.63
FeOT (wt.%)	7.56
LOI (wt.%)	<0.01
Fe3+/Fe2+	0.3
Sc (ppm)	12.50
Cr	10.9
Co	25.7
V	208
Ni	21
Zn	77.9
Cu	122
W	4.8
Mo	5.6
Sb	0.387
As	8.3
Li	15
Be	7.7
Zr	200
Hf	4.25
Nb	34
Ta	1.82
Th	19.6
U	5.74
Rb	308
Cs	17.8
Sr	1100
Ba	2480
Pb	28
Y	26
La	52.4
Ce	102.3
Nd	42
Sm	9.84
Eu	2.22
Tb	0.972
Yb	2.11
Lu	0.300
Au (ppb)	<7

Table 3: *Vesuvius tephra (A.D. 1631-1944)*

Sample no.	V06T1	V06T2	V44T3	V44T2	V44T1
Date A.D.	1906	1906	1944	1944	1944
Laboratory no.	W-246602	W-246603	W-246607	W-246604	W-246606
Analysis code	b,d	b,d	a,d	a,d	a,d
SiO2 (wt.%)	47.9	46.8	47.9	47.9	47.9
TiO2	1.01	0.94	1.07	1.04	1.01
Al2O3	15.2	16.5	10.2	12.3	13.1
Fe2O3	3.46	4.96	3.39	4.03	4.21
FeO	4.6	2.9	4.4	3.9	3.6
MnO	0.14	0.14	0.13	0.14	0.13
MgO	6.38	4.65	10.4	8.74	8.01
CaO	12.3	9.73	18.7	16.2	15.1
Na2O	2.14	2.51	1.08	1.44	1.52
K2O	5.72	6.96	2.49	3.73	4.45
H2O+	0.39	0.58	0.39	0.34	0.27
H2O-	0.06	0.25	0.20	0.12	0.50
P2O5	0.84	0.82	0.51	0.61	0.64
CO2	0.01	<0.01	0.02	0.01	0.03
F	0.20	0.25	0.080	0.12	0.12
Cl	0.73	0.15	0.12	0.15	0.16
S	<0.01	0.07	<0.01	<0.01	<0.01
-O=F,Cl,S	0.28	0.17	0.07	0.09	0.09
Total	100.80	98.03	101.01	100.68	100.66
FeOT (wt.%)	7.71	7.36	7.45	7.52	7.39
LOI (wt.%)	<0.01	1.33	<0.01	0.22	0.06
Fe3+/Fe2+	0.68	1.54	0.69	0.93	1.05
Sc (ppm)	29.4	20.5	61.0	48.9	44.6
Cr	135	76.3	204	150	150
Co	na	na	35.1	32.7	31.4
V	261	213	383	338	313
Ni	45	29	77	60	56
Zn	73	74	60	66.3	60
Cu	119	146	44	59	63
W	na	na	na	na	na
Mo	3.8	4.7	<2	<5	<5
Sb	0.31	0.44	<0.3	0.20	0.25
As	7.7	15.6	3.0	4.5	4.6
Li	13	15	6.6	8.9	8.8
Be	6.5	6.7	3.2	4.3	4.6
Zr	206	185	159	176	161
Hf	4.75	4.40	5.52	5.06	5.00
Nb	20	14	11	12	18
Ta	1.60	1.65	0.70	0.96	1.02
Th	17.1	18.5	7.10	9.8	11.1
U	5.03	5.55	2.12	2.84	3.06
Rb	224	293	99	139	185
Cs	13.3	17.4	5.63	8.57	11.0
Sr	900	926	499	639	698
Ba	1730	1880	809	1200	1310
Pb	25	41	8.5	17	15
Y	27	23	29	28	27
La	46.4	47.0	26.2	32.0	33.9
Ce	94.7	93.6	61.8	69.6	73.4
Nd	42.7	41.2	36.5	38.7	36.6
Sm	10.43	9.62	10.13	9.98	9.84
Eu	2.37	2.17	2.30	2.27	2.23
Tb	1.23	1.05	1.15	1.16	1.14
Yb	2.22	2.06	2.13	2.09	2.06
Lu	0.341	0.318	0.312	0.302	0.294
Au (ppb)	<9	<6	<1	<1	<2

Table 4: *Vesuvius lavas (A.D. 1631-1944)*

Sample no.	V5	V7	V1	V11	V12	V22
Date A.D.	1631	1631	1631	1697	1697	1737
Laboratory no.	W-246232	W-246234	W-246228	W-246238	W-246239	W-246249
SiO2 (wt.%)	48.2	47.5	48.7	47.6	47.6	47.8
TiO2	0.93	1.01	0.93	1.04	1.05	0.97
Al2O3	14.5	17.4	17.7	17.0	17.1	17.7
Fe2O3	5.83	5.43	3.26	3.22	3.11	8.08
FeO	2.0	3.0	4.6	5.0	5.1	0.64
MnO	0.13	0.14	0.15	0.15	0.15	0.15
MgO	6.81	4.30	3.70	4.57	4.45	3.80
CaO	12.0	9.77	8.40	10.0	9.88	8.99
Na2O	1.82	2.24	2.45	2.20	2.31	2.49
K2O	5.92	7.14	8.08	7.06	7.07	7.25
H2O+	0.26	0.26	0.49	0.39	0.39	0.38
H2O-	0.08	0.02	0.18	0.23	0.24	0.22
P2O5	0.80	0.93	0.79	0.94	0.96	0.86
CO2	0.13	0.01	0.02	0.01	0.03	0.05
F	na	na	na	na	na	na
Cl	na	na	na	na	na	na
S	na	na	na	na	na	na
-O=F,Cl,S	na	na	na	na	na	na
Total	99.41	99.15	99.45	99.41	99.44	99.38
FeOT (wt.%)	7.24	7.88	7.53	7.90	7.90	7.91
LOI (wt.%)	0.71	0.15	0.44	0.45	0.49	0.78
Fe3+/Fe2+	2.62	1.63	0.64	0.58	0.55	11.36
Cr (ppm)	144	<20	<20	<20	<20	<20
Ni	56	39	33	47	43	25
Zn	70	69	81	75	79	74
Cu	95	120	103	115	113	118
Zr	173	198	231	198	200	232
Nb	24	23	33	30	28	29
Rb	246	267	309	285	281	302
Sr	774	1030	1140	995	1010	1000
Ba	1630	2230	2240	2000	2060	2000
Y	22	29	27	29	28	32
La	27	38	38	35	34	49
Ce	70	91	100	90	84	99

Table 4:

Sample no.	V26	V27	V37	V35	V33	V32
Date A.D.	1751	1751	1760	1760	1760	1760
Laboratory no.	W-246253	W-246254	W-246264	W-246262	W-246260	W-246259
SiO2 (wt.%)	48.4	48.3	48.1	48.2	47.9	47.9
TiO2	0.98	0.98	0.97	0.98	0.98	0.97
Al2O3	15.8	16.0	14.1	14.8	15.8	15.8
Fe2O3	4.37	5.14	2.55	3.61	3.22	2.77
FeO	3.7	3.0	5.0	4.2	4.6	5.0
MnO	0.14	0.13	0.14	0.14	0.14	0.14
MgO	5.85	5.59	7.19	6.34	5.82	5.81
CaO	11.3	11.0	13.0	12.4	11.2	11.2
Na2O	1.80	1.69	1.81	1.81	2.26	2.20
K2O	6.14	6.35	5.34	5.81	6.26	6.23
H2O+	0.46	0.34	0.45	0.35	0.28	0.44
H2O-	0.18	0.16	0.08	0.19	0.05	0.02
P2O5	0.77	0.79	0.81	0.80	0.87	0.86
CO2	0.02	0.01	0.02	0.02	0.02	0.02
F	na	0.15	0.13	na	na	na
Cl	na	0.13	0.20	na	na	na
S	na	<0.01	<0.01	na	na	na
-O=F,Cl,S	na	0.10	0.11	na	na	na
Total	99.91	99.66	99.79	99.65	99.40	99.36
FeOT (wt.%)	7.63	7.62	7.30	7.45	7.50	7.50
LOI (wt.%)	0.45	0.46	0.14	0.31	0.06	0.20
Fe3+/Fe2+	1.06	1.54	0.46	0.77	0.63	0.50
Cr (ppm)	38	43	84	37	28	54
Ni	40	38	51	54	42	42
Zn	67	68	66	73	64	64
Cu	100	136	125	113	120	127
Zr	166	162	186	173	199	203
Nb	20	19	23	24	26	27
Rb	265	279	219	215	252	256
Sr	866	890	749	833	857	868
Ba	1930	1970	1540	1850	1740	1790
Y	23	22	26	26	23	30
La	30	28	32	28	32	46
Ce	73	86	78	86	89	98

Table 4:

Sample no.	V40	V69	V76	V82	V83	V85
Date A.D.	1767	1839	1855	1858	1861	1867
Laboratory no.	W-246267	W-246297	W-246304	W-246367	W-246368	W-246370
SiO2 (wt.%)	47.4	48.0	47.6	47.3	47.9	47.4
TiO2	1.07	0.99	1.03	1.07	1.00	1.04
Al2O3	17.8	17.6	16.1	17.6	17.3	18.2
Fe2O3	2.59	2.65	3.44	2.08	5.01	2.37
FeO	5.8	5.6	4.7	6.1	3.4	6.1
MnO	0.15	0.15	0.15	0.16	0.15	0.16
MgO	4.11	4.06	5.37	3.98	4.12	3.48
CaO	9.07	9.29	11.1	8.67	9.41	8.86
Na2O	2.70	2.45	2.38	2.63	2.50	2.75
K2O	7.25	7.31	6.32	7.25	7.26	7.28
H2O+	0.34	0.29	0.39	0.31	0.12	0.36
H2O-	0.02	0.28	0.32	0.20	0.15	0.15
P2O5	1.01	0.89	0.84	0.97	0.88	0.84
CO2	0.01	0.01	0.01	0.04	0.03	0.02
F	0.22	na	na	0.16	0.22	0.25
Cl	0.18	na	na	0.18	0.40	0.37
S	<0.01	na	na	<0.01	<0.05	<0.05
-O=F,Cl,S	0.14	na	na	0.12	0.20	0.20
Total	99.58	99.57	99.75	98.53	99.65	99.43
FeOT (wt.%)	8.13	7.98	7.79	7.97	7.91	8.23
LOI (wt.%)	<0.01	0.13	0.05	0.17	0.24	0.10
Fe3+/Fe2+	0.40	0.43	0.66	0.31	1.33	0.35
Cr (ppm)	<20	28	71	35	36	22
Ni	25	17	36	17	25	12
Zn	66	68	71	73	80	87
Cu	132	124	114	116	124	131
Zr	235	207	204	233	221	236
Nb	32	26	29	26	31	27
Rb	289	317	275	324	340	313
Sr	1060	992	977	1030	1020	1130
Ba	2080	1980	1790	2120	2010	1990
Y	28	26	27	21	25	20
La	29	50	47	49	54	62
Ce	97	105	96	116	99	122

Table 4:

Sample no.	V87	V90	V94	V102	V101	V99
Date A.D.	1868	1872	1881	1895-1899	1895-1899	1895-1899
Laboratory no.	W-246372	W-246376	W-246380	W-246388	W-246387	W-246385
SiO2 (wt.%)	48.0	48.3	48.1	47.7	47.8	47.5
TiO2	0.99	0.92	0.93	1.02	1.01	1.01
Al2O3	17.7	18.0	17.8	18.4	18.5	18.5
Fe2O3	3.09	4.71	2.00	3.14	2.08	5.24
FeO	4.9	3.3	5.9	5.3	6.2	3.3
MnO	0.15	0.15	0.15	0.16	0.16	0.16
MgO	4.02	3.82	3.95	3.24	3.20	3.15
CaO	8.75	9.06	9.08	8.87	8.78	8.70
Na2O	2.68	2.51	2.52	2.90	2.81	2.77
K2O	7.73	7.54	7.40	7.53	7.58	7.49
H2O+	0.19	0.31	0.46	0.27	0.12	0.35
H2O-	0.11	0.08	0.26	0.07	0.22	0.18
P2O5	0.87	0.87	0.92	0.86	0.86	0.84
CO2	0.02	0.05	0.05	0.01	0.01	0.09
F	na	na	na	na	na	na
Cl	na	na	na	na	na	na
S	na	na	na	na	na	na
-O=F,Cl,S	na	na	na	na	na	na
Total	99.20	99.62	99.52	99.47	99.33	99.28
FeOT (wt.%)	7.68	7.54	7.70	8.13	8.07	8.02
LOI (wt.%)	0.22	0.34	0.48	0.01	0.06	0.62
Fe3+/Fe2+	0.57	1.28	0.31	0.53	0.30	1.43
Cr (ppm)	34	30	26	23	<20	<20
Ni	21	22	21	15	14	13
Zn	67	73	74	78	89	82
Cu	137	122	120	137	140	124
Zr	194	201	197	233	244	239
Nb	22	30	27	30	32	36
Rb	335	296	284	320	318	327
Sr	1020	1080	1070	1190	1200	1210
Ba	2120	2350	2390	2210	2230	2230
Y	19	24	21	22	28	25
La	52	46	40	64	54	59
Ce	109	108	96	124	124	125

Table 4:

Sample no.	V110	V106	V155	V151	V150	V104
Date A.D.	1906	1906	1906	1906	1906	1906
Laboratory no.	W-246395	W-246391	W-246601	W-246598	W-246597	W-246389
SiO2 (wt.%)	47.6	47.9	47.7	47.4	47.6	47.7
TiO2	1.01	1.01	1.02	1.02	1.03	1.02
Al2O3	16.5	16.6	17.4	17.7	17.8	18.1
Fe2O3	4.05	2.83	4.22	3.92	4.05	4.71
FeO	4.2	5.3	4.2	4.5	4.4	3.8
MnO	0.15	0.15	0.15	0.16	0.16	0.16
MgO	4.95	4.92	4.19	3.86	3.80	3.57
CaO	10.8	10.7	9.96	9.62	9.49	9.12
Na2O	2.35	2.27	2.46	2.45	2.57	2.70
K2O	6.49	6.54	6.88	7.05	7.12	7.35
H2O+	0.23	0.52	0.31	0.38	0.42	0.36
H2O-	0.10	0.10	0.15	0.28	0.14	0.05
P2O5	0.83	0.83	0.84	0.86	0.86	0.85
CO2	0.02	0.02	0.05	0.02	0.01	0.02
F	na	na	na	na	na	na
Cl	na	na	na	na	na	na
S	na	na	na	na	na	na
-O=F,Cl,S	na	na	na	na	na	na
Total	99.28	99.69	99.53	99.22	99.45	99.51
FeOT (wt.%)	7.85	7.85	8.00	8.03	8.04	8.04
LOI (wt.%)	0.21	0.29	0.26	0.45	0.37	0.19
Fe3+/Fe2+	0.87	0.48	0.90	0.78	0.83	1.11
Cr (ppm)	56	61	44	28	26	29
Ni	26	30	20	14	19	12
Zn	64	80	69	84	77	70
Cu	132	127	131	135	128	130
Zr	206	210	225	230	228	219
Nb	22	27	24	26	30	20
Rb	267	281	299	289	304	313
Sr	992	1020	1060	1070	1100	1120
Ba	1920	1970	2070	2100	2140	2190
Y	19	22	23	20	22	18
La	53	53	49	53	62	53
Ce	105	108	114	109	120	121

Table 4:

Sample no.	V109	V112	V113	V117	V142	V139
Date A.D.	1906	1913-1944	1929	1929	1944	1944
Laboratory no.	W-246394	W-246397	W-246398	W-246402	W-246589	W-246586
SiO2 (wt.%)	47.9	48.3	47.9	47.5	48.1	48.3
TiO2	1.00	0.92	1.01	1.04	0.89	0.90
Al2O3	18.4	17.6	16.6	18.1	18.1	18.3
Fe2O3	1.80	0.93	3.37	2.42	3.14	3.29
FeO	6.2	6.8	5.2	6.1	4.7	4.6
MnO	0.16	0.14	0.15	0.16	0.14	0.14
MgO	3.29	4.18	4.76	3.45	3.69	3.68
CaO	8.53	9.14	10.6	8.92	8.82	8.60
Na2O	2.83	2.39	2.19	2.75	2.68	2.55
K2O	7.90	7.46	6.53	7.24	7.64	7.77
H2O+	0.27	0.34	0.51	0.57	0.25	0.29
H2O-	0.05	0.04	0.14	0.15	0.09	0.10
P2O5	0.92	0.91	0.88	0.85	0.88	0.88
CO2	0.01	0.01	0.03	0.03	0.01	0.02
F	0.18	na	na	0.25	na	na
Cl	0.29	na	na	0.26	na	na
S	0.02	na	na	0.02	na	na
-O=F,Cl,S	0.16	na	na	0.18	na	na
Total	99.59	99.16	99.87	99.63	99.13	99.42
FeOT (wt.%)	7.82	7.64	8.23	8.28	7.52	7.56
LOI (wt.%)	0.11	0.06	0.20	0.29	<0.01	0.14
Fe3+/Fe2+	0.26	0.12	0.58	0.36	0.60	0.64
Cr (ppm)	22	31	33	27	31	26
Ni	8	30	24	13	17	23
Zn	73	80	78	79	64	80
Cu	121	126	122	140	115	119
Zr	228	184	197	229	201	190
Nb	33	24	32	27	28	31
Rb	345	302	253	305	306	313
Sr	1160	1010	988	1150	1100	1100
Ba	2190	2290	2150	2040	2350	2380
Y	25	21	28	21	21	22
La	56	43	44	59	46	56
Ce	124	97	99	119	103	109

Table 4:

Sample no.	V131	V129	V140	V144	V126	V134
Date A.D.	1944	1944	1944	1944	1944	1944
Laboratory no.	W-246578	W-246576	W-246587	W-246591	W-246573	W-246582
SiO2 (wt.%)	48.2	48.2	48.3	48.2	48.2	48.2
TiO2	0.91	0.90	0.90	0.90	0.89	0.89
Al2O3	18.2	18.1	18.3	18.2	18.3	18.3
Fe2O3	2.47	3.13	3.71	2.78	3.54	4.89
FeO	5.3	4.7	4.2	5.0	4.3	3.1
MnO	0.14	0.14	0.14	0.14	0.14	0.14
MgO	3.68	3.68	3.67	3.62	3.58	3.52
CaO	8.74	8.75	8.76	8.70	8.55	8.48
Na2O	2.63	2.57	2.55	2.60	2.57	2.53
K2O	7.68	7.68	7.69	7.75	7.74	7.77
H2O+	0.38	0.33	0.30	0.28	0.29	0.31
H2O-	0.02	0.05	0.05	0.14	0.11	0.08
P2O5	0.88	0.87	0.88	0.88	0.87	0.88
CO2	0.01	0.01	0.02	0.01	0.01	0.04
F	na	na	na	na	na	na
Cl	na	na	na	na	na	na
S	na	na	na	na	na	na
-O=F,Cl,S	na	na	na	na	na	na
Total	99.24	99.11	99.47	99.20	99.09	99.13
FeOT (wt.%)	7.52	7.51	7.54	7.50	7.49	7.50
LOI (wt.%)	<0.01	0.11	0.09	0.09	0.21	0.20
Fe3+/Fe2+	0.42	0.60	0.80	0.50	0.74	1.42
Cr (ppm)	28	28	23	29	26	30
Ni	30	17	19	18	17	14
Zn	88	70	77	70	73	67
Cu	124	115	115	118	121	114
Zr	202	200	197	198	198	203
Nb	27	24	25	31	34	29
Rb	293	298	293	298	308	309
Sr	1080	1070	1100	1100	1090	1090
Ba	2330	2360	2390	2390	2380	2370
Y	21	22	20	23	26	22
La	36	52	62	44	53	57
Ce	103	102	104	115	111	115

Table 4:

Sample no.	V128	V138	V147	V123
Date A.D.	1944	1944	1944	1944
Laboratory no.	W-246575	W-246585	W-246594	W-246570
SiO2 (wt.%)	48.4	48.2	48.4	48.3
TiO2	0.90	0.89	0.89	0.89
Al2O3	18.4	18.5	18.4	18.6
Fe2O3	3.03	2.88	2.99	1.91
FeO	4.8	4.9	4.8	5.8
MnO	0.14	0.14	0.14	0.14
MgO	3.52	3.48	3.47	3.39
CaO	8.47	8.46	8.40	8.27
Na2O	2.58	2.63	2.68	2.60
K2O	7.91	7.85	7.85	7.99
H2O+	0.33	0.28	0.43	0.21
H2O-	0.05	0.10	0.18	0.09
P2O5	0.89	0.88	0.87	0.89
CO2	0.02	0.01	0.03	0.01
F	na	na	na	na
Cl	na	na	na	na
S	na	na	na	na
-O=F,Cl,S	na	na	na	na
Total	99.44	99.20	99.53	99.09
FeOT (wt.%)	7.52	7.50	7.49	7.52
LOI (wt.%)	0.04	0.12	0.31	<0.01
Fe3+/Fe2+	0.57	0.53	0.56	0.30
Cr (ppm)	27	<20	25	20
Ni	27	20	18	21
Zn	89	82	71	86
Cu	124	122	120	127
Zr	193	197	195	192
Nb	30	31	24	26
Rb	308	315	296	311
Sr	1090	1100	1090	1070
Ba	2360	2390	2410	2380
Y	24	26	18	19
La	52	51	42	47
Ce	102	113	112	107

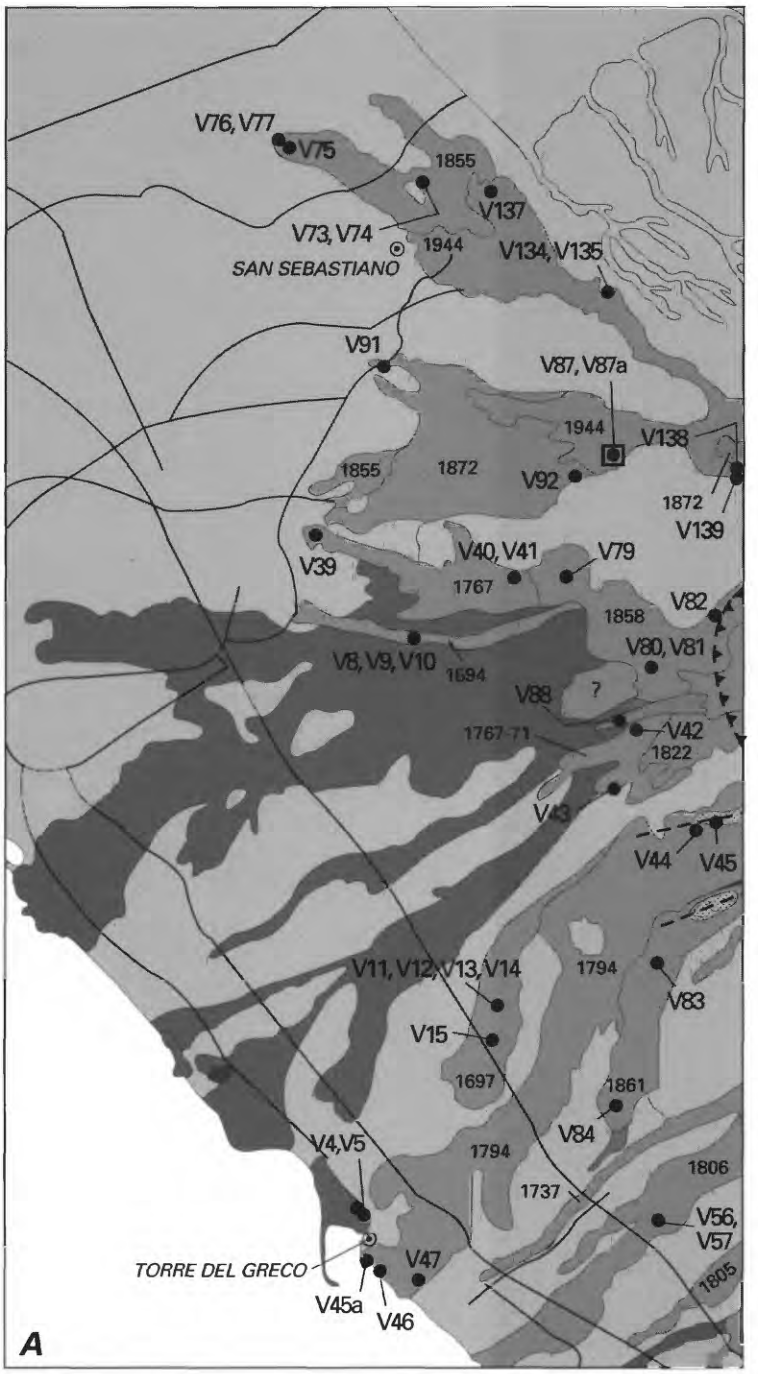

Figure 1. Vesuvius sample location map A.

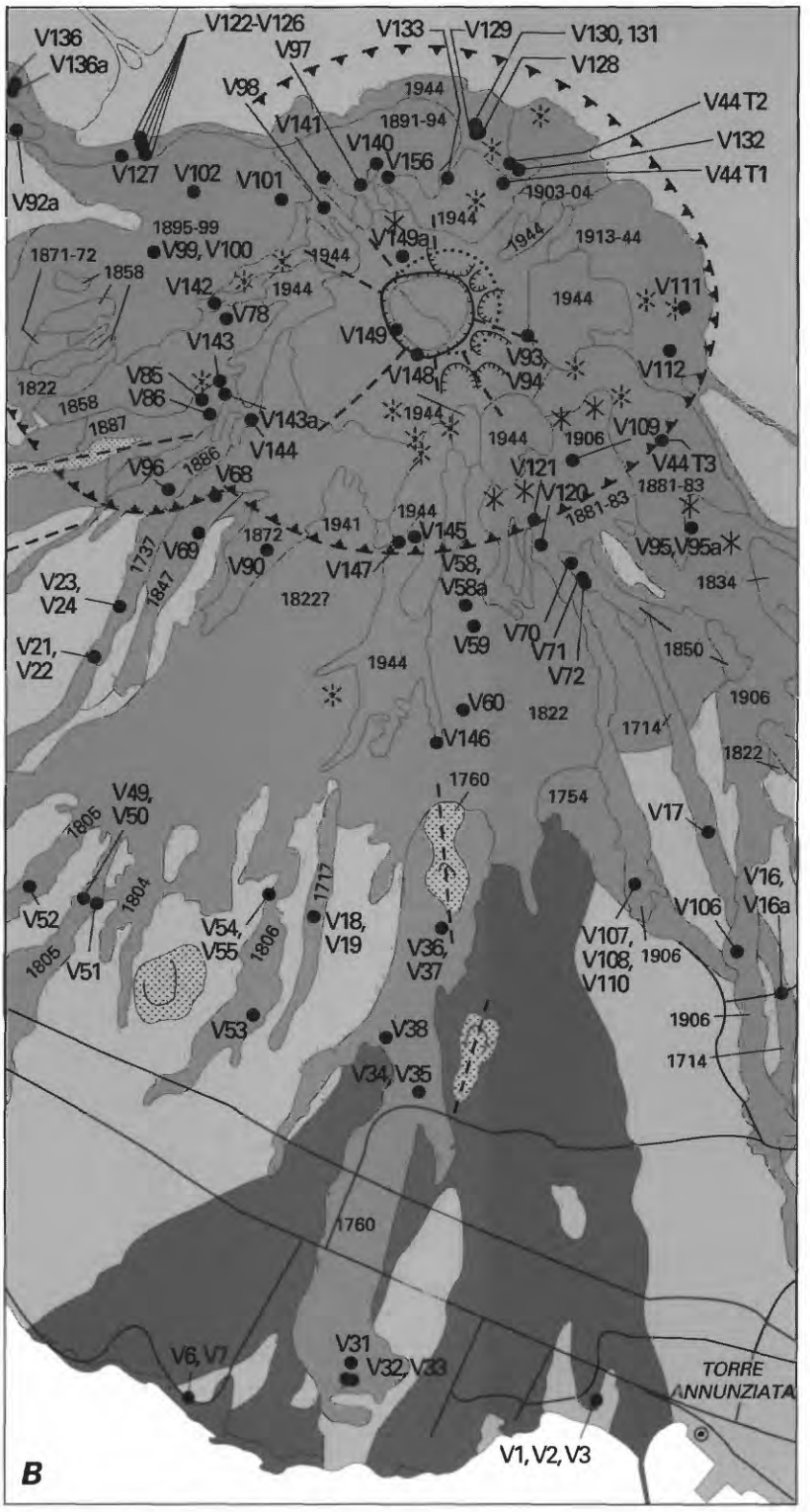

Figure 2. Vesuvius sample location map B.

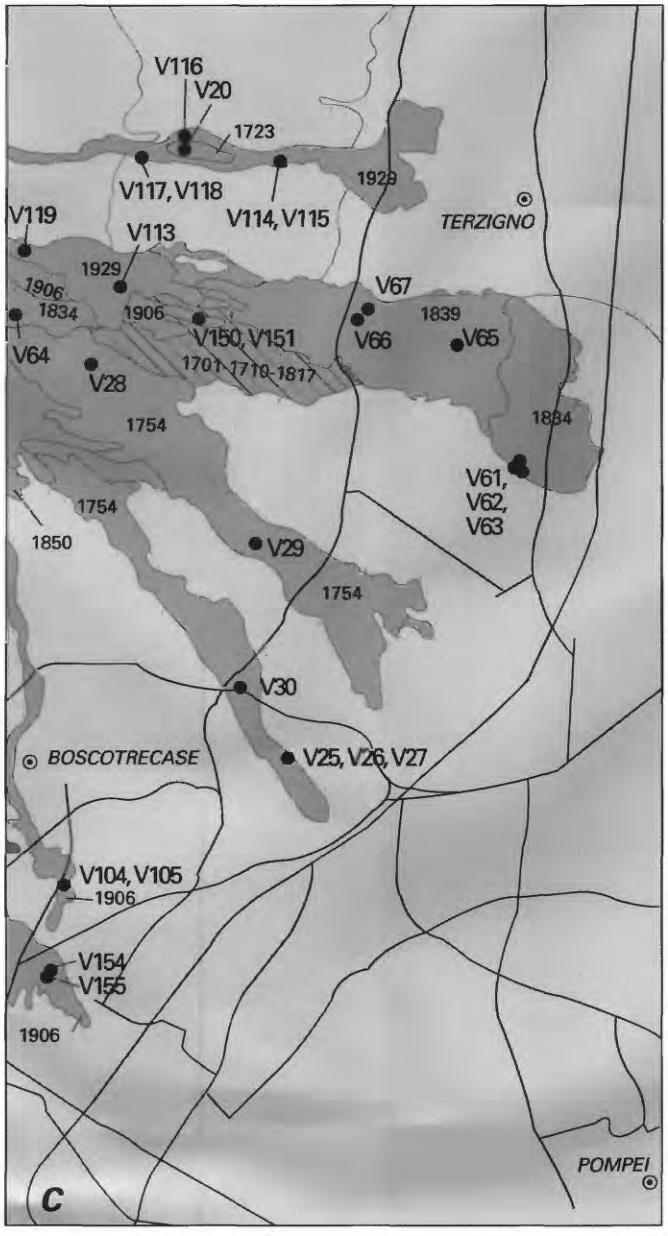

Figure 3. Vesuvius sample location map C.

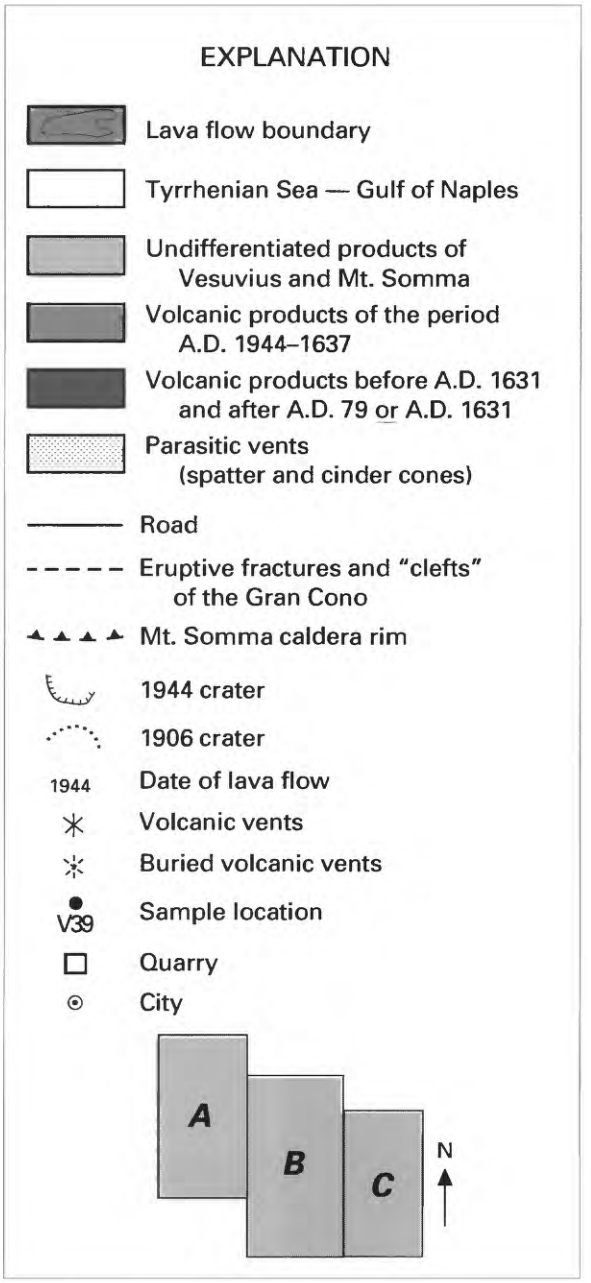

Figure 4. Explanation of sample location maps A, B, and C.