DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1993 (SHEET 1 OF 3)

INTRODUCTION

This map of the western part of the Springerville volcanic field, Arizona, differs from conventional geologic maps in that it portrays lithologic, stratigraphic, paleomagnetic, geochemical, and chronologic data. The volcanic units are presented on the lithologic map (sheet 1) and in the correlation of map units (sheet 2) in a format designed to facilitate the interpretation of the magmatic evolution of the volcanic field.

An effort was made to map each lava flow as a discrete unit based on lithology and age, and to correlate each flow with the volcanic vent (cinder cone) from which it was extruded (sheets 1, 3). Where cinder cones could be identified as vent(s) for a unit, the cinder cone(s) tephra was outlined and it and its related flows identified by numbers. Seventeen isolated tephra deposits could not be related to any surrounding flow, and are identified as discrete units. Contacts are drawn between flows of similar age and lithology that are interpreted to represent separate eruptions, a distinction important in understanding the petrogenesis of each flow and of the field as a whole. In addition, flow-by-flow mapping is critical to establishing a temporal correlation of units within polarity-stratigraphic sequences.

Twelve lithologic types of basalt flows are identified and mapped in the Springerville volcanic field, based on the type and abundance of phenocrysts greater than 0.33 mm, a size identifiable by hand lens. The lithologic types are defined in table 1 and on figure 1. The volcanic rocks of the Springerville field consist of alkali olivine basalt, hawaiite, mugearite, and benmoreite, according to the classification of Coombs and Wilkinson (1969); a plot showing volume-percent phenocrysts in each of the lithologic types in that classification is shown in figure 2. Representative major-element analyses of volcanic rocks in the Springerville volcanic field (fig. 3) are given in table 2 on sheet 2.

Table 1. ***Criteria and symbols for volcanic lithologic types (referred to in the broadest sense as phenocryst-bearing basalts)***

[Minerals smaller than 0.33 mm are defined as groundmass phases. Rock nomenclature is from Coombs and Wilkinson (1969); AOB, alkali olivine basalt; H, hawaiite; M, mugearite; B, benmoreite; those in parentheses indicate less common rock type

Unit symbol	Lithologic type/ nomenclature	Criterion
a	Olivine-pyroxene basalt/AOB	Basalt with more than 2 percent olivine and pyroxene phenocrysts only.
b	Picritic basalt/AOB	Basalt with more than 11 percent olivine phenocrysts only.
c	Olivine basalt/AOB (H)	Basalt with fewer than 11 percent and more than 6 percent olivine phenocrysts only.
d	Sparse olivine basalt/AOB (H)	Basalt with fewer than 6 and more than 2 percent olivine phenocrysts only.
e	Olivine-pyroxene-plagioclase basalt/AOB (H)	Basalt with more than 2 percent olivine, pyroxene, and plagioclase phenocrysts only.
f	Dikytaxitic basalt/AOB (H)	Basalt with a dikytaxitic texture excluding those with plagioclase phenocrysts.
g	Olivine-feldspathic basalt/AOB (H)	Basalt with more than 2 percent olivine and plagioclase only.
h	Aphyric basalt/(AOB) H	Basalt with fewer than 2 percent phenocrysts.
i	Pyroxene basalt/H	Basalt with more than 2 percent pyroxene phenocrysts only.
j	Quartz basalt/H	Any basalt with more than 2 percent quartz phenocrysts.
k	Hornblende basalt/H (M)	Any basalt with more than 2 percent hornblende phenocrysts.
l	Feldspathic basalt/ H M B	Basalt with more than 2 percent plagioclase phenocrysts only.

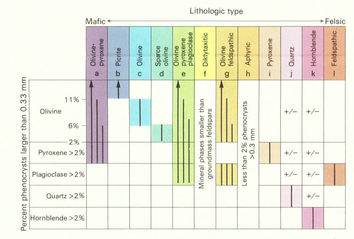

Figure 1. Volume-percent phenocrysts present in each lithologic type of basalt. Vertical bar shows range of percentage of phenocrysts; +/– indicates presence (in any amount) or absence of a mineral in the lithologic type.

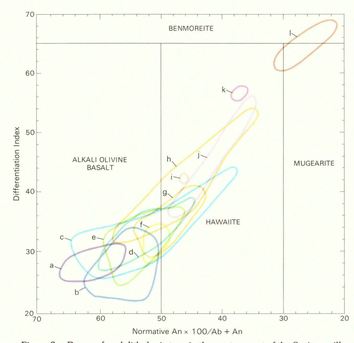

Figure 2. Range of each lithologic type in the western part of the Springerville volcanic field (classification of Coombs and Wilkinson, 1969). Differentiation Index from Thornton and Tuttle (1960).

Eight geographic areas separate, as nearly as possible, discrete packages of flows within which the most complete stratigraphic correlations can be made. In addition, these geographic areas help identify flows which, because of physical proximity, may be related to common magma batches. Only the composite flow unit QTsf transcends geographic area boundaries.

One hundred and twenty-one individual flow units are recognized in the western part of the Springerville volcanic field and are described on sheet 2. Flow units are distinguished one from another by the proportion of minerals, by the size of phenocrysts, and on morphologic criteria. Each flow unit is interpreted as a discrete magma that was extruded in a single eruption from a single vent. Where individual units could not be separated, possibly because the flows were products of more than one magma batch extruded at different times and (or) from different vents, they are mapped as a composite flow unit. Several flow units have been interpreted as composite units because they contain two or more vents that are widely spaced. Nine of the twenty-four composite flow units recognized in the map area contain mixed lithologies; these units are designated on the maps by the dominant lithologic type. Some mixed lithologies may represent a magma of variable phenocryst content emplaced during a single eruptive episode.

INFORMAL UNIT NOMENCLATURE FOR VOLCANIC ROCKS

Map symbols for volcanic units are composed of three or four letters, and in most cases a subscripted number (for example, Qlh_2). The upper-case letter(s) designates the geologic age (period) to which the unit is assigned [Q, Quaternary; QT, Quaternary and (or) Tertiary; T, Tertiary]. The first lower-case letter is the first letter in the name of the geographic area in which the unit is located: s, Show Low Creek; w, White Lakes Basin; m, Morgan Mountain; e, Ecks Mountain; b, Blue Ridge Mountain; l, Lake Mountain; h, Haystack Mountain; and n, North Fork White River. The final letter refers to one of the 12 lithologic types of volcanic rocks shown on figures 1 and 2 and on table 1. A subscripted number is used when more than one unit of the same lithologic type and geologic age (Q, QT, or T) occurs in the same geographic area, with the stratigraphically oldest unit numbered 1. The unit used as an example (Qlh_2) is therefore the second oldest aphyric unit of Quaternary age in the Lake Mountain area.

POLARITY-CHRONOLOGIC AGE GROUPS

To portray the general chronologic evolution of the Springerville volcanic field, the flow units have been assigned to five polarity-chronologic age groups on the basis of K-Ar ages (Condit and Shafiqullah, 1985; Peirce and others, 1979) and the polarity-chronostratigraphic positions of the units (Condit, 1984). Magnetopolarities were determined from core samples collected from flows and oxidized agglutinate on cinder cones. The boundaries of the age groups are placed at magnetopolarity reversals in the polarity-chronologic sequence of Mankinen and Dalrymple (1979). Because each flow unit may have been emplaced over a period of time, each unit is located in the correlation diagram (sheet 2) in the center of its estimated time of eruption. Some apparent mismatches between the magnetopolarity of a flow unit and its position in the polarity-chronologic sequence are due to insufficient data to assign the unit to a discrete time period matching its polarity. To show spatially the chronologic development of the Springerville volcanic field, the five age groups are shown by color on the appropriate volcanic units on sheet 3.

VENT AND FLOW IDENTIFICATION NUMBERS

Vent numbers assigned to the cinder cones are based on their locations. The numbers uniquely identify the township, range, and section in which the vent is located; if more than one vent occurs in a section, letters are added. The first number of the four-digit vent number (for example, V0327) designates the township (if there are two digits, only the second is shown). The second number designates the range (only the second digit is shown). The third and fourth numbers represent the section, ranging from 01 to 36. Thus vent number V0327 is in T. 10 N., R. 23 E., sec. 27. The degradation of cinder cones is estimated by observation, and (or) the height/width ratio, according to the terminology of Wood (1980). Flows traced to a source vent bear the vent number without the prefix "V".

ACKNOWLEDGMENTS

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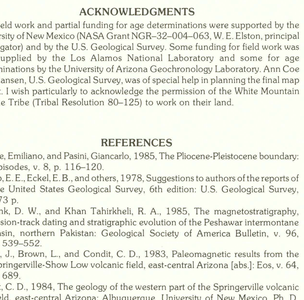
EXPLANATION

[Map unit symbols are described on sheet 2]

- **Contact**—Dashed where approximately located. Relative ages of adjacent units (shown only where relation can be observed): O, older; Y, younger
- **Flow front**—Dashed where approximately located. Hachures on side of overlying flow
- **Fault**—Dotted where concealed; U, upthrown side; D, downthrown side
- **Direction of flow**
- **Outline and number of volcanic vent**
- **Number of vent source for lava flow**—Queried where uncertain
- **Locality and age of radiometrically dated (K-Ar) sample**—Age in millions of years (Ma)
- **Paleomagnetic sample locality**—NM, normal polarity; R, reversed polarity; T, transitional polarity
- **Locality and number of representative sample**—XRF (X-ray fluorescence) analyses in table 2 (sheet 2)
- **Outline of geographic subdivision**
- **Strike and dip of sedimentary rocks**



INDEX MAP OF ARIZONA

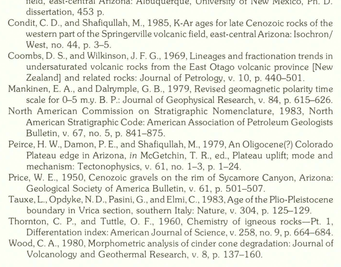


Figure 3. Index showing location of Springerville volcanic field (in pink), location of mapped area (black line), and U.S. Geological Survey 1:24,000-scale quadrangles used on base maps:

1. Point of the Mountain, 1971
2. Taylor, 1970
3. Mesa Redonda NW, 1971
4. Mesa Redonda, 1971
5. Show Low North, 1970
6. Silver Springs, 1971
7. Ortega Mountain, 1971
8. Show Low South, 1977
9. Lakeside, 1976
10. Sponseller Mountain, 1976
11. Faught Ridge, 1977
12. Indian Pine, 1977
13. McNary, 1977
14. Alchesay Flat, 1976

LITHOLOGIC MAP OF THE WESTERN PART OF THE SPRINGERVILLE VOLCANIC FIELD, EAST-CENTRAL ARIZONA

By
Christopher D. Condit

1991

For sale by U.S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225