MAPS SHOWING DISTRIBUTION, COMPOSITION, AND AGE OF EARLY AND MIDDLE CENOZOIC VOLCANIC CENTERS IN COLORADO AND UTAH

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DISCUSSION

This map is the second of a series showing the distribution, composition, and age of early and middle Cenozoic volcanic centers in the western conterminous United States. The maps are designed primarily as a data base of igneous systems, a major geologic environment known to promote and host mineral deposits. The data shown provide the basic information necessary for derivative studies such as the development of geologic concepts to identify and assess igneous-related mineral deposits and(or) mineralized systems. In addition, this map series shows the temporal and spatial relationships of early and middle Cenozoic igneous rocks and their geochemical associations, at a single common map scale, within the many different igneous centers in the western states. This map series can also be used as a base for studies of volcanology, volcanotectonics, and the general geology of volcanic and related rocks. Original sources were consulted wherever possible in construction of these maps, but in areas of meager data I interpreted the general composition and age of the igneous rocks. This procedure was necessary in order to resolve internal problems and to maintain a standard treatment for meaningful comparison of data throughout the map series.

In this map series the early and middle Cenozoic time frame extends from about 58 Ma to 16 Ma; 16 Ma is the maximum age cutoff for a published map series designed as a guide for the evaluation of igneous-related geothermal resources (for the comparable Colorado and Utah region, see Luedke and Smith, 1978). Within this early and middle Cenozoic time frame, the ages of the volcanic rocks are arbitrarily divided into three time increments: 58–37 Ma, 37–24 Ma, and 24–16 Ma. The ages of 58, 37, and 24 Ma, respectively, represent the approximate Paleocene-Eocene, Eocene-Oligocene, and Oligocene-Miocene boundaries (Berggren and others, 1985).

Igneous rocks of the early and middle Cenozoic time frame are principally related to volcanotectonic activity occurring within this time span. Most volcanic units shown on the map generally fit well within the selected time increments. Locally, a few rock units that are at or within about a million years of a boundary (particularly the 24-Ma boundary) were included with the dominant younger or older unit of the region in order to maintain geologic, petrologic, and tectonic continuity. A specific rock unit or volcanic field may have some ages that appear inconsistent with the majority of ages. For example, the extensive andesitic unit (<24 Ma) occupying part of the Black Mountains and much of the Tushar Mountains and Sevier Plateau south of the Marysvale region in south-central Utah (see also inset B) is a widespread assemblage of stratovolcano deposits consisting of vent and alluvial outflow facies that ranges in age from late Oligocene to early Miocene. Based on the dominance of age data and consideration of geologic and petrologic continuity, this unit was arbitrarily assigned as shown.

Some Laramide magmatic and tectonic events that started in Late Cretaceous and Paleocene time continued into middle Eocene time (Mutschler and others, 1987), or served as precursors to similar events later in the Cenozoic. Volcanism and associated intrusions commenced in the very latest Eocene following a quiescence or waning of volcanic activity in late Eocene time throughout much of the Southern Rocky Mountains. This volcanism continued on a major scale through the Oligocene, into the Miocene, to the onset of late Cenozoic volcanism and associated extensional tectonism characteristic of the Basin and Range province but also reflected in bordering regions (Christiansen and Lipman, 1972; Lipman and others, 1972; Christiansen, 1989). Because of the extraordinary amount of new geological, geochemical, geophysical, and geochronological data released during the last two decades, reanalysis of both the Laramide and post-Laramide volcanotectonic events is justified. Keith and Wilt (1986) have done such a synthesis of Laramide events principally in Arizona and environs; Mutschler and others (1987) similarly studied the effects of late Mesozoic and Cenozoic magmatism in Colorado and environs, emphasizing a three-fold magmatic time frame of (1) Laramide (75–42 Ma), (2) middle Tertiary (40–26 Ma), and (3) late Cenozoic (25–0).

In order to show some continuity to the earlier magmatic activity, a few igneous areas are outlined that are related to known Laramide magmatic or tectonic belts within the Rocky Mountain Cordillera, for instance those having ages spanning the 58 Ma limit for this map series. A number of mostly plutonic masses (pre-58 Ma) are shown in the northeast-trending Colorado mineral belt (Tweto, 1975; Mutschler and others, 1987).

The volcanic rocks, and associated contemporaneous plutonic rocks, have been classified using a non-genetic system into five major types based primarily upon their known or inferred silica content:

1. Feldspathoidal basalts including basanite, tephrite, and other rare alkalic rocks	Less than 46 percent SiO_2
2. Basalt, including trachybasalt, and hawaiite	46 – 62 percent SiO_2
3. Andesite, including trachyandesite, and phonolite	54 – 62 percent SiO_2
4. Dacite, including rhyodacite, quartz latite, and trachyte	62 – 70 percent SiO_2
5. Rhyolite	More than 70 percent SiO_2

This simplistic rock classification, not desirable for detailed volcanological purposes, emphasizes the dominant rock type within a given region, although in any specific area several rock types may be intermixed. For example, the widespread andesitic unit in the San Juan volcanic field of southwestern Colorado (see also inset C) includes other intermediate compositional rocks ranging from basaltic andesite to quartz latite. This compositionally heterogeneous unit consisting of stratovolcano deposits that include near-source rocks (vent facies) and extensive surrounding and coalescing marginal volcaniclastic aprons (outflow facies) accumulated early in the eruptive history of this field; because the outflow facies is the more prevalent of the two facies and because they have not been differentiated everywhere within this field, I have shown the unit on sheet 2 as entirely volcaniclastic to distinguish it from younger, dominantly lava-flow units. This rock classification is the same as that used on the map of late Cenozoic volcanic rocks (Luedke and Smith, 1978), thereby permitting easy comparison.

Isotopically determined age data are referenced to the first or original source where possible. Potassium-argon ages have been recalculated where necessary using the conversion tables of Dalrymple (1979) prepared for the decay constants and isotopic abundances adopted by the IUGS Subcommission on Geochronology (Steiger and Jager, 1977). Multiple ages at a given locality are shown when cartographically possible; some areas, for example, in the Greeley, Denver, and Leadville 1° × 2° quadrangles (fig. 1) have more ages than can be shown, and an arbitrary selection was made.

Cited references for geologic, age, and chemical information are indicated in figure 2. Several important general references are cited separately at the end and are not numbered chronologically.

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