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Porphyry-type mineralization and alteration in the Organ mining district, south-central New Mexico

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Introduction

Middle Tertiary porphyry-type copper and molybdenum mineralization occurs in the northern part of the Organ Mountains and the southernmost part of the San Andres Mountains in south-central New Mexico, approximately 15 mi northeast of Las Cruces (Fig. 1). This mineralization, which is here termed the Organ porphyry deposit, occurs in and adjacent to a quartz monzonite stock (the Sugarloaf Peak quartz monzonite), which intrudes Paleozoic sedimentary and middle Tertiary volcanic rocks. As a result of late Tertiary block faulting, this mineralization has been rotated approximately 10–20° to the west about a north–south horizontal axis. Subsequent erosion has exposed a considerable vertical section of the deposit.

Dunham (1935) provided the first comprehensive account of the geology and ore deposits of the Organ Mountains. Seager (1981), in his update of the geology of the Organ Mountains, recognized and described the Organ cauldron and its associated batholithic rocks. Mining activity in the Organ mining district, which includes the study area, dates back to the early 1830's and possibly as far back as the 1770's (Eveleth, 1983). Lead, zinc, copper, silver, and minor amounts of gold were the principal metals mined from several high-grade deposits adjacent to the porphyry-type mineralization. Most of this ore was mined during three periods: 1900 to 1909, during the First World War, and in the early 1940's.

Since the early 1960's the Organ mining district has drawn considerable attention from various exploration companies attracted by the potential for a large tonnage porphyry copper and/or molybdenum deposit and/or associated manto and skarn-type deposits of copper, lead, zinc, and silver. Most of this exploration activity has been restricted to a 5–6 mi^2 area north and east of Organ (Fig. 2). Here, more than 40 holes, ranging in depth from 65 to 1,360 m, have been drilled. The purpose of this paper is to present a general description of the geology, mineralization, and economic potential of the Organ porphyry deposit. Petrographic and chemical data from outcrops and 36 drill holes in the study area have been summarized by Newcomer (1984).

Regional geology

The Sugarloaf Peak quartz monzonite is the dominant host of the Organ porphyry deposit. It is a late phase of the Organ batholith and has been dated at 32.8 m.y. (Seager, 1981). The close spatial and temporal relationships between the Organ batholith (Tertiary intrusive rocks in Fig. 2) and a caldera sequence (Tertiary volcanic rocks in Fig. 2) suggest that the porphyry deposit developed in or adjacent to a large silicic cauldron complex, the volcano-plutonic complex proposed by Seager and Brown (1978). Newcomer (1984) outlined evidence which suggests that localization of the Organ Mountains volcano-plutonic complex as well as the Organ porphyry deposit was influenced by Laramide structures. Of particular interest is the ☞

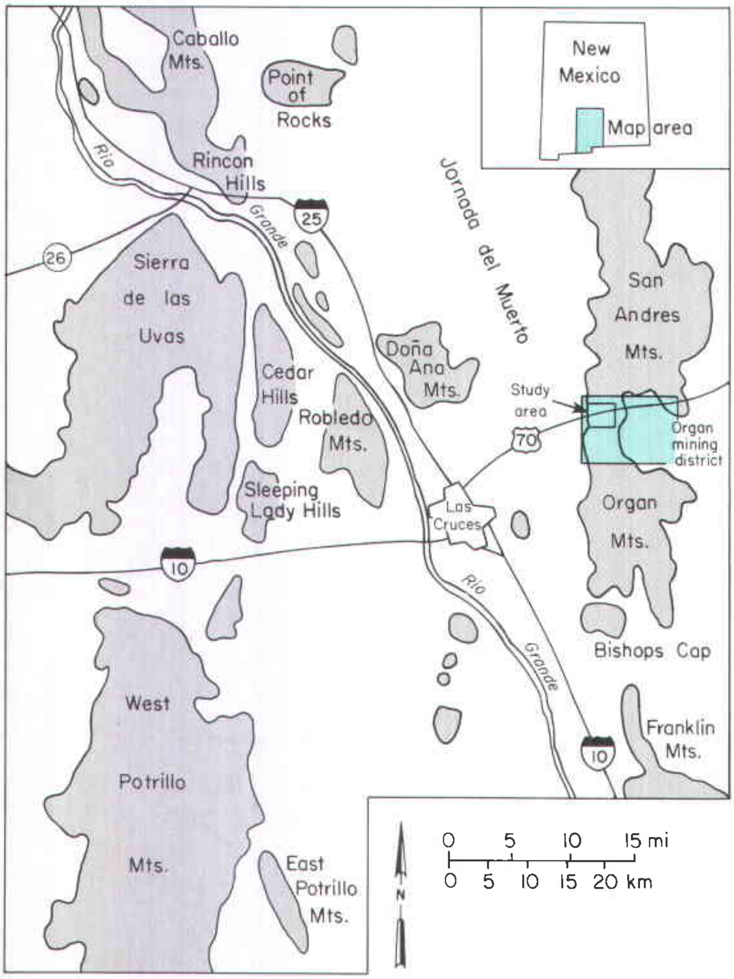

FIGURE 1—Location map of the study area and the Organ mining district in south-central New Mexico (after Seager, 1981).

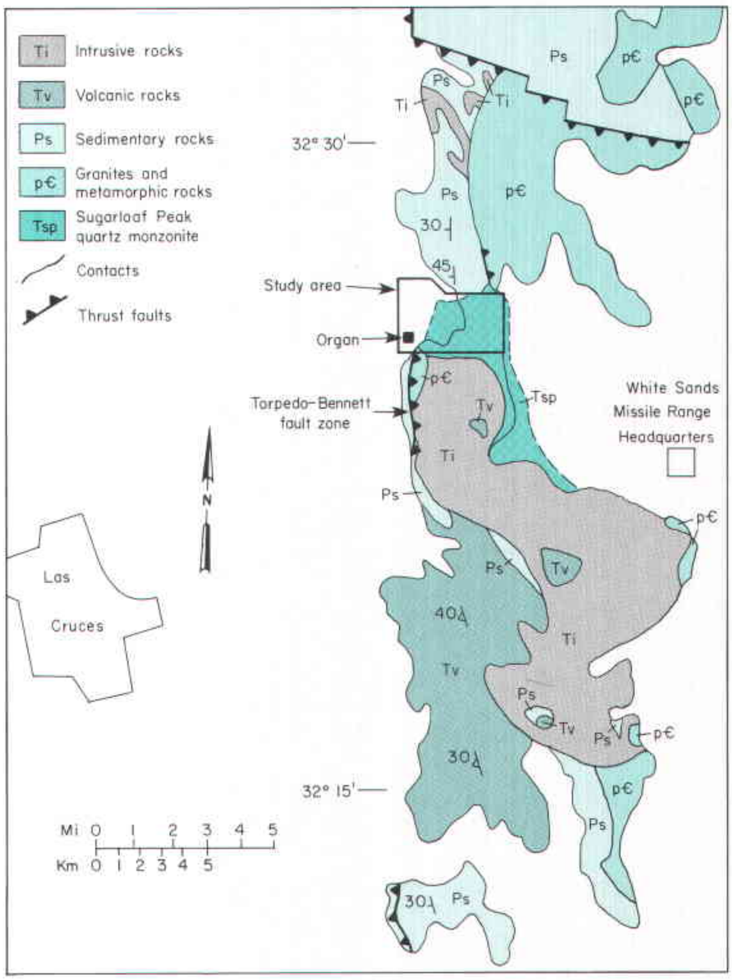

FIGURE 2—Generalized geologic map of the Organ and southern San Andres Mountains and the location of major Laramide structures (after Seager, 1981).

Torpedo–Bennett fault zone, a north-trending, east-dipping reverse fault of apparent Laramide age (Fig. 2). High-grade base- and precious-metal mineralization in the Organ mining district is spatially associated with this structure. In the study area, the northern extension of this fault zone appears to be the contact between Sugarloaf Peak quartz monzonite and Paleozoic sedimentary rocks (Fig. 3).

Tectonic setting

Most of the large porphyry copper deposits in the southwestern U.S. are associated with intrusions emplaced in the upper crust during the Laramide orogeny, a period of northeast-directed compression 40–80 Ma. This compressional regime may have been related to high convergence rates and/or times when convergence style changed along a destructive plate margin (Heidrick and Titley, 1982). In the southwestern U.S. tectonic style changed about 30–40 Ma to an evolving back-arc or inter-arc setting, with northeast–southwest extension (Lipman, 1981; Keith, 1982; Eaton, 1982; Zoback et al., 1981). The Trans-Pecos region of west Texas probably underwent northeast-directed compression until approximately 30 Ma when northeast–southwest extension began (Price and Henry, 1984). This transition seems to have developed slightly earlier in southern New Mexico, approximately 31–33 Ma. The predominant northwest trend of essentially coeval dikes and fissure veins, which cut the Sugarloaf Peak quartz monzonite, provides evidence for northeast–southwest extension at approximately 32.8 Ma (Newcomer et al., 1983). Northwest-trending, early Tertiary extensional basins in south-central New Mexico began to develop approximately 28–29 Ma (Seager et al., 1984). Therefore, the Organ porphyry deposit appears to have developed in a middle Tertiary back-arc extensional setting associated with the transition from Laramide subduction-related compression to late Tertiary basin-and-range rifting.

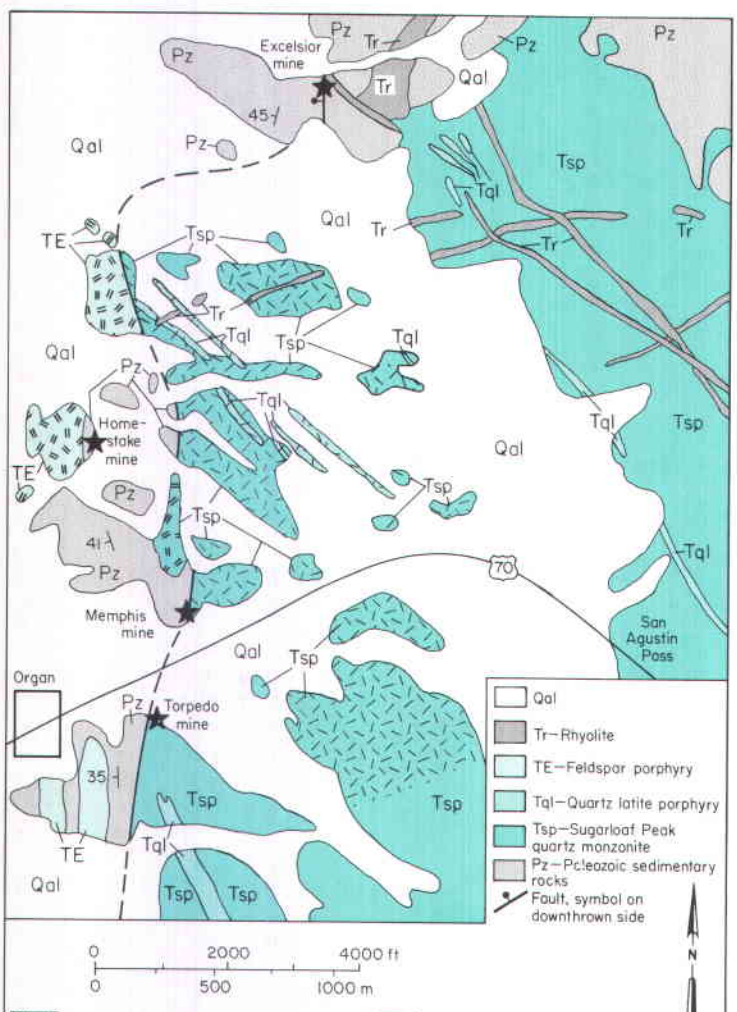

FIGURE 3—Generalized geologic map of the Organ porphyry deposit, south-central New Mexico (after Newcomer, 1984).

Stratigraphy

There are three principal rock types associated with the Organ porphyry deposit: quartz monzonite (the Sugarloaf Peak quartz monzonite), quartz latite porphyry, and feldspar porphyry. Seager (1981) refers to the quartz monzonite and feldspar porphyry as Sugarloaf Peak quartz monzonite porphyry, and he refers to the quartz latite porphyry as hornblende monzonite porphyry. These rocks intrude west-dipping Paleozoic sedimentary and middle Tertiary volcanic rocks and are intensely altered locally by hydrothermal fluids (Seager, 1981; Newcomer, 1984). Rhyolite dikes and sills, which show only minor sericitization, cut across hydrothermally altered rocks. Spatial and temporal relationships among these major rock types were inferred from field mapping and study of drill core (Newcomer, 1984) and are shown on the geologic map (Fig. 3) and in cross section (Fig. 4).

Sugarloaf Peak quartz monzonite

This unit is light gray to pink, medium- to coarse-grained hypidiomorphic granular, and it is generally porphyritic. It consists primarily of square pink perthite (30–40%) and tabular plagioclase (30–38%). Quartz occurs as interstitial grains and generally makes up less than 20% of the unaltered rock. Ferromagnesian minerals, which include black biotite and pale-green hornblende, compose 7–8% of the rock.

Feldspar porphyry

Feldspar porphyry occurs as sills in Paleozoic and volcanic strata adjacent to the quartz monzonite stock. It is invariably altered hydrothermally, and original igneous textures are typically obscured. It is generally gray to white and has a phenocryst content that ranges from 30–50%. Altered plagioclase and K-feldspar are the dominant phenocrysts along with minor altered biotite. The fine-grained groundmass consists primarily of quartz and K-feldspar, although this assemblage is typically obscured by alteration minerals.

Quartz latite porphyry

This unit occurs as a dike swarm that cuts quartz monzonite and Paleozoic strata. It is gray to green and generally contains 20–40% phenocrysts in a fine-grained groundmass. The phenocrysts consist of distinctive square, orange orthoclase perthite (10–25 mm on edge) and tabular plagioclase (2–10 mm in length). The groundmass consists primarily of quartz and K-feldspar, with minor sulfides, plagioclase, hornblende, and biotite. The presence of quartz "eyes" (2–4 mm in diameter) in the quartz latite was used to distinguish this

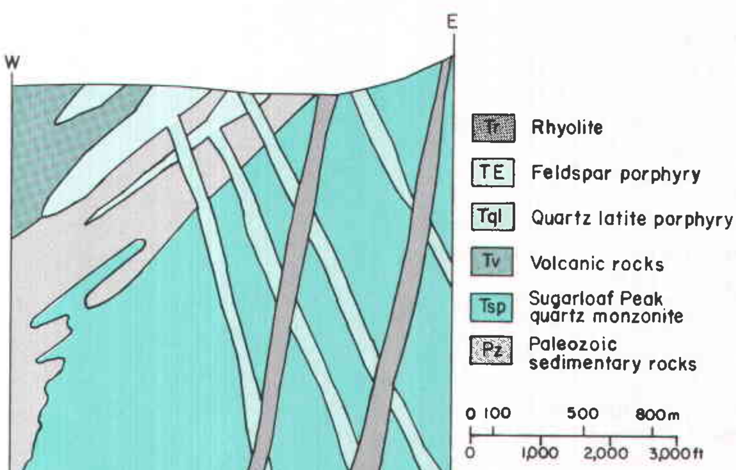

FIGURE 4—Schematic east-west vertical section through the Organ porphyry deposit, south-central New Mexico (after Newcomer, 1984).

rock from porphyritic quartz monzonite and feldspar porphyry. This criterion for distinguishing these rock types was particularly important when dealing with highly altered samples.

Rhyolite

Rhyolites in the study area are flow-banded and occur as dikes that trend predominantly in northwest and east–west directions. They are generally greenish gray to tan, fine grained, and nonporphyritic, although they contain small feldspar and quartz phenocrysts locally.

Aplite

Numerous aplitic and aplorhyolitic bodies occur in and adjacent to the quartz monzonite. They are buff to orange and have a sugary, fine-grained, nonporphyritic texture. Minerals present include quartz, orthoclase, albite, biotite, and accessory iron oxides. Locally, the aplites contain disseminated pyrite, molybdenite, and chalcopyrite.

Paleozoic sedimentary rocks

The Paleozoic sedimentary section consists of more than 2,000 ft of Cambrian to Pennsylvanian carbonates, shales, and minor sandstones. The section has been intruded by quartz monzonite, quartz latite porphyry, and feldspar porphyry, and near intrusive contacts have been metamorphosed to hornfels, marble, and skarn.

Volcanic rocks

The middle Tertiary volcanic section consists predominantly of andesitic and rhyolitic rocks that unconformably overlie the Paleozoic section. These rocks are intruded in a complex manner by irregular bodies of feldspar porphyry and are intensely altered hydrothermally.

Hydrothermal alteration

The earliest stage of hydrothermal alteration associated with the Organ porphyry deposit consists of a broad area of diffuse potassic alteration characterized by secondary biotite and secondary K-feldspar. Potassic alteration was observed in nearly all outcrop and core samples of the quartz monzonite and appears to grade laterally into unaltered and propylitically altered rock. Superimposed on the potassic alteration are large zones of pervasive quartz-sericite and vein-associated quartz-sericite alteration. Argillic alteration and propylitic alteration are weakly developed and are not widespread. Mapped zones of quartz-sericite alteration are shown in Figure 3.

Potassic alteration

Within the Sugarloaf Peak quartz monzonite, the earliest manifestation of hydrothermal alteration consists of widespread but sporadic secondary biotite. It typically occurs as selvages in K-feldspar-quartz veins, in thin discontinuous veinlets, and as clots of fine-grained shreds replacing igneous biotite, hornblende, and in some cases plagioclase. Hydrothermal biotite is commonly altered to a pale-green, weakly pleochroic chlorite with anomalous brown interference colors. Anhydrite is also a common accessory mineral of this alteration assemblage and occurs as vein-filling material and as an intragranular product associated with the alteration of plagioclase and hornblende.

Hydrothermal K-feldspar appears to be as widespread as hydrothermal biotite. Two types of K-feldspar alteration are evident: a pervasive type, which is less common and occurs as a flooding of the groundmass in porphyritic rocks; and a second type, which occurs as diffuse veinlets with quartz. Hydrothermal K-feldspar commonly replaces plagioclase and biotite.

Quartz-sericite alteration

The most prominent alteration assemblage exposed in the study area is quartz + sericite (Fig. 3). Three forms of this alteration have been recognized: a pervasive type, a vein and veinlet type, and a selective type, which may actually be an intermediate argillic alteration assemblage (Newcomer, 1984). Pervasive quartz-sericite alteration occurs in the western part of the study area and strongly affects the feldspar porphyry and locally the quartz latite porphyry and quartz monzonite. All rocks affected by this alteration are fine to coarse grained, light gray to white, and are composed almost entirely of quartz, sericite, and pyrite. In some cases the outlines of phenocrysts are preserved. Vein and veinlet quartz-sericite alteration occurs over a wide area and is the predominant alteration type in the deposit. This alteration consists of quartz-sericite envelopes (generally 1 to several cm wide) enclosing quartz-pyrite and quartz-sulfide veins and veinlets. Selective quartz-sericite alteration is common particularly adjacent to and between quartz-sericite-sulfide veins. Here, plagioclase and hornblende have been replaced by fine-grained mixtures of quartz, sericite, clays, and carbonate. Biotite is partially to totally replaced by pale-green chlorite.

Argillic alteration

Intense argillic alteration is characterized by an abundance of clay minerals as replacements of plagioclase, K-feldspar, and ferromagnesian minerals and is rare in the quartz monzonite and quartz latite porphyry phases. Locally it occurs in shear zones where it appears to have resulted from the migration of acidic supergene fluids along fractures. In the subsurface, where it may be of hydrothermal rather than of supergene origin, it occurs in altered volcanic rocks and feldspar porphyry sills.

Propylitic alteration

Weakly developed propylitic alteration of quartz monzonite and quartz latite porphyry occurs locally. It is identified by the presence of pale-green chlorite, which is pseudomorphic after biotite, and the weak alteration of plagioclase to clay, minor sericite, and carbonate. Epidote, chlorite, leucoxene(?), carbonate, and clay replace hornblende. Quartz and K-feldspar are unaltered.

Stockwork veining and mineralization

Stockwork mineralization in the Organ porphyry deposit occurs principally as veins and veinlets of pyrite, quartz, and minor amounts of molybdenite, chalcopyrite, sphalerite, and galena (Newcomer, 1984). This mineralization is exposed over an area of approximately 5 mi^2. Copper values range from 0.001 to 0.065% in the Sugarloaf Peak quartz monzonite stock and increase to several percent adjacent to the stock. Molybdenum mineralization is associated with stockwork fractures in the Sugarloaf Peak quartz monzonite and quartz latite porphyry. Molybdenum concentrations are generally less than 0.01%, but locally values reach as high as 0.15%. The highest molybdenum values appear to be in the central part of the quartz latite porphyry dike swarm where quartz veining is strong.

Three stages of stockwork veining have been recognized. An early stage consists of hydrothermal biotite veinlets, quartz-K-feldspar veins, and two types of quartz veins with associated pyrite and molybdenite mineralization. Late-stage veining consists of quartz-pyrite veinlets with or without quartz-sericite envelopes and quartz-carbonate veins and veinlets with pyrite, chalcopyrite, sphalerite, and galena mineralization. Sphalerite and galena-bearing veins generally occur near the contact between Paleozoic rocks and quartz monzonite or quartz latite porphyry. Calcite and gypsum veins characterize a post-mineralization stage and crosscut and/or occur within earlier veins and veinlets.

Vein densities in the Sugarloaf Peak quartz monzonite stock appear to be related to only two or three major fracturing events. This is evidenced by the simple nature of vein paragenesis and relatively low fracture densities within the stock. This mild nature of fracturing has strong implications regarding the uneconomic nature of the Organ porphyry deposit. Norton (1982) noted the importance of throughgoing, continuous, and numerous fractures in the development of high permeability, a feature that is thought to be required

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in the genesis of productive porphyry-type deposits (Titley et al., 1986; Heidrick and Titley, 1982).

Economic implications

Economic porphyry molybdenum and porphyry copper deposits in the southwestern U.S. are known to be associated with caldera complexes (Lipman 1983; Lipman and Sawyer, 1985). Molybdenum sulfide and chalcopyrite mineralization has been encountered in sedimentary rocks along the southern ring-fracture zone during recent drilling in the Valles caldera (north-central New Mexico; Geotimes, 1985, pp. 13–14). This caldera-related mineralization may represent the upper part of a copper–molybdenum porphyry system that is similar to the Organ porphyry deposit. Similar, but unstudied, mineralization may also be developed in the central part of the Organ Mountains, and to our knowledge there has been little or no exploration of this target. Here, Seager (1981) recognized a widespread area of disseminated sulfide mineralization and alteration within the Granite Peak phase of the Organ batholith.

This large granite stock is younger than the Sugarloaf Peak quartz monzonite and is considered to be the youngest plutonic phase of the Organ batholith. Thus, it appears that there may be two separate porphyry systems present in the Organ Mountains, both of which are Oligocene age.

Under present economic conditions, the Organ porphyry deposit does not appear to be a viable exploration target. Although the volume of mineralized rock is large, concentrations of copper and molybdenum in the stock are well below typical cutoff grades for economic copper and molybdenum ores (0.25% Cu and 0.1% Mo; Peters, 1978). As mentioned in the previous section, low fracture/vein densities within the stock may have inhibited the development of higher concentrations of copper and molybdenum within the stock. Mineralizing fluids seem to have been channeled for the most part along the Torpedo–Bennett fault zone and quartz monzonite contacts and adjacent to quartz latite porphyry dikes and feldspar porphyry sills. Most of the past mining activity has been concentrated along these structures and high-grade Cu-Pb-Zn-Ag manto and skarn-type deposits developed along these structures adjacent to the Organ porphyry deposit continue to be viable exploration targets in the Organ mining district.

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New Mexico Geological Society News

The time is fast approaching for election of 1987 New Mexico Geological Society officers. Members should receive their ballots, as well as the updated publication list and notice of our annual January guidebook sale soon.

Even though we've just recently returned from the 1986 Fall Field Conference in the Truth or Consequences area, it's not too early to start planning for fall 1987! The next field conference will be based in Clayton, New Mexico, and will address the interesting geologic problems of the Dry Cimarron, Raton Basin, and San Juan volcanic field region. Papers are being solicited now on any aspect of the local geology. If you would like to contribute a paper to the guidebook, please contact one of the organizers (Spencer Lucas or Adrian Hunt, University of New Mexico, Department of Geology, Albuquerque, NM 87131, 505/277-4204) and give them a title and length estimate.

Do you have any ideas for future fall field conferences? NMGS now has a Future Field Conference Committee; the members, Chuck Chapin, John Hawley, and Bruce Black, would love to hear your feedback. By the way, we're not only looking for good ideas, but also the hard-working organizers to go with them!

In memorium

The New Mexico Geological Society wishes to note that a dear friend and member, Robert Wellnitz of Los Alamos, passed away on July 3, 1986. Bob was a mainstay of the Los Alamos Geological Society, where he served as president and a driving force behind student scholarship activities. Together with his wife, Beverly, Bob was an active participant in NMGS fall field conferences, and he helped provide countless student scholarships for these annual meetings. In keeping with the couple's long-standing dedication to geological education in New Mexico, Beverly Wellnitz has established the Wellnitz Scholarship Fund with a gift of $10,000 to the New Mexico Geological Society. The society is very grateful for this donation and will begin to make student scholarship awards in 1987. Those individuals interested in contributing to the Wellnitz Scholarship Fund may do so through gifts to the New Mexico Geological Society in memory of Robert Wellnitz.

—*Robyn Wright*
NMGS Secretary