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Pumice mining and environmental concerns in New Mexico

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Abstract

Pumice is a volcanic rock, commonly rhyolitic, used as building material since the Roman Empire because of its light color, light weight, and cellular structure. It also has been used extensively as an abrasive. In 1993, 492,000 metric tons (mt) of pumice and pumicite (very finely divided pumice fragments) valued at $14.9 million were produced in the United States by 12 producers, three of them in New Mexico. Oregon was the largest domestic producer of pumice and pumicite, followed in descending order by New Mexico, California, Arizona, Idaho, and Kansas. New Mexico's active pumice mines are on the south and east flanks of the Jemez Mountains where the Guaje Pumice Bed of the Bandelier Tuff and El Cajete Member of the Valles Rhyolite are mined. An area of past mining for pumice is East Grants Ridge north of Grants. Other pumice sites include water-laid lump pumice and pumicite near San Antonio, New Mexico, and scattered deposits in the Mogollon–Datil volcanic field of southwest New Mexico.

Much of New Mexico's active pumice mining is on federal land in the Jemez Mountains, principally land administered by the U.S. Forest Service (USFS). The USFS requires a number of steps to be taken before a permit is issued, including the submission of an operating plan. The plan outlines all activities at the proposed mine from preliminary work through actual mining to completion of reclamation. As mandated by the National Environmental Policy Act (NEPA), an environmental study must be completed to analyze the potential effects of mining on local environments. Professional surveys must be completed to determine the presence or absence of prehistoric and historic artifacts or features and endangered species of plants or animals. The information in these surveys can delay or in some cases prevent mining. More often, however, the operating plan is modified to incorporate any additional protective measures that were identified in the environmental analysis. Public involvement is sought in determining whether a plan will be approved. This is done through the USFS contacting groups or individuals who have expressed interest in the past, publishing notices, and holding public meetings. The USFS is required to monitor the mining operation once a plan is approved. A reclamation bond is collected, and the mining company is released from its obligations outlined in the operation plan only after all required reclamation has been completed. A balanced approach, in which the need for minerals is considered along with the need for proper reclamation of mining sites, is necessary to maintain a productive industry in a scenic area of New Mexico.

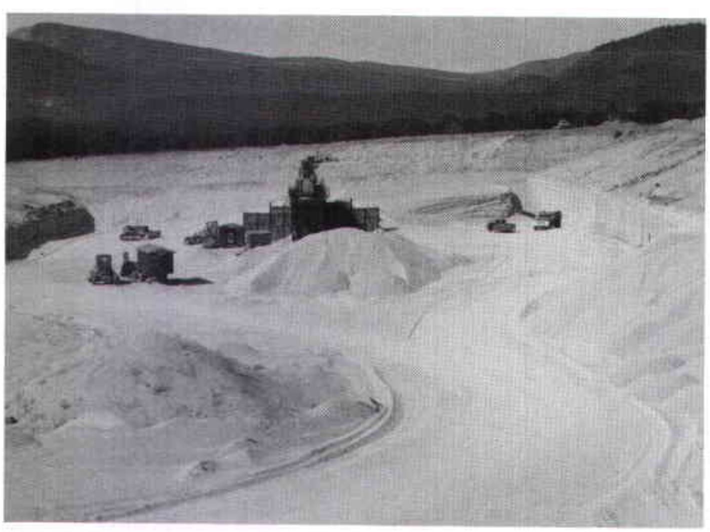

FIGURE 1—General Pumice mine on the east flank of the Valles caldera showing unconsolidated pumice that is moved by bulldozer to the screening plant (structure near center) that loads trucks for movement to market.

Introduction

Pumice is a light-colored, light-weight igneous rock with cellular structure and is formed by a process of explosive volcanism. It commonly has a rhyolitic (siliceous) composition but may have a rhyodacitic composition with increasing sodium content (Bates and Jackson, 1987). Pumice occurs as fragmental aggregates of volcanic glass froth in which individual particles range from coarse-sand size to blocks meters in diameter. Very finely divided fragments are called pumicite (also called volcanic ash or dust), which consists largely of angular and curved particles of the shattered vesicle (bubble) walls of pumice (Thrush, 1968). Pumicite has been subjected to additional explosive forces during the volcanic event whereby the previously formed cellular structure is broken down to form a very fine, unconsolidated material. Because of the cellular structure, light weight, and insulating properties, both pumice and pumicite have been used extensively as building materials since the Roman Empire (Meisinger, 1985). Before World War II, it was used largely as an abrasive; nearly all consumption since has been in the construction industry.

Pumice and pumicite are currently mined by open-pit methods (Meisinger, 1985). Removal of overburden is by standard earth-moving equipment and is usually kept to a minimum by careful selection of the mining site. Because most deposits are unconsolidated (Fig. 1), mining equipment such as bulldozers, pan scrapers, draglines, and power shovels can be used without blasting. Modern highway construction uses much the same equipment. ☞

Also in this issue

Processing generally incorporates scalping screens, rolls and hammer mills, rotary dryers, pneumatic concentration tables (on occasion), and various screen-sizing and blending systems (Meisinger, 1985). Scalping screens are used to remove impurities such as organic matter and oversize rock fragments. Further reduction of oversize material is accomplished with rolls and hammer mills. Pumice with high moisture is dried in rotary dryers either before or after crushing. To meet end-user specifications, various screening and blending systems are used. The sized products are usually bagged for shipment (Fig. 2) by truck or rail.

Grades of pumice vary for specific uses, but particle sizes are generally designated as lump, coarse, intermediate, fine, and extra fine (Meisinger, 1985). Specifications for ground pumice sizes used for abrasives range from −6 mesh for cleaning to −300 mesh for polishing. Size gradations for pumice aggregate are best determined by testing each pumice source, but, in general, they conform to specifications for all lightweight aggregates. Important factors to be considered for pumice aggregate use in building materials are bulk density, compressive strength and modulus of elasticity, fire resistance, sound transmission, and thermal conductivity.

In 1993, 492,000 metric tons (mt) of pumice and pumicite valued at $14.9 million were produced in the United States by 12 producers; two others were idle (Bolen, oral communication 1994). The average value of pumice and pumicite was $30.27/mt FOB mine. The US 1991 volume of 401,000 mt represented about 4% of the world's total output of pumice and related materials (Bolen et al., 1992). In 1991, the leading producer of pumice and related volcanic materials was Italy with 49% of the world's estimated total of 10,802,000 mt, followed by Greece with 13%, and Spain with 8%.

Oregon was the largest domestic producer of pumice and pumicite in 1993, followed in descending order by New Mexico, California, Arizona, Idaho, and Kansas. California, New Mexico, and Oregon produced about 85% of the national total (Bolen, oral communication 1994). In 1992, New Mexico produced about 60,500 mt of pumice with a value of $1.5 million (K. S. Hatton, written communication 1993). The U.S. construction industries consumed 75% of the total produced, followed by textile laundries and abrasive users (Bolen, 1993). Other uses for pumice and pumicite included adsorbents, horticulture, concrete aggregate, diluents, fillers, filter aids, insulating medium, and landscaping. In 1992, imports accounted for 12% of U.S. consumption. In recent years, Greece has been the chief foreign supplier of pumice and pumicite (75%), followed by Mexico (7%), Ecuador (7%), and Turkey (4%).

Domestic production in 1983 was 407,000 mt by 21 producers from 22 operations in eight western states (Meisinger, 1985). These figures represent about the same tonnage of product produced in 1991 and 1992, but there was a reduction in the number of producers and operations as well as in the number of employees engaged in pumice mining. In 1983, employment at U.S. pumice and pumicite mining and milling operations was approximately 60 workers, and average annual productivity was approximately 7,500 mt per production employee (Meisinger, 1985). However, office personnel, mechanics, and other service employees greatly increase the number of paid employees involved in pumice mining. Copar Pumice, Inc., has two mines in the Jemez Mountains, Las Conchas and Guaje Canyon pumice mines, and in 1992 they employed 12 people at those mines and two plants plus 9 individuals as contact haulers; the same year total New Mexico employment in the pumice mines and mills was 44 and included 13 contract haulers (K. S. Hatton, written communication 1993). Adding clerical staff brings the number of individuals employed in mining of pumice by one company to a significant number. Pumice producers' salaries generate addition support jobs in nearby commercial centers. This multiplier effect is enhanced because many pumice operations are rural.

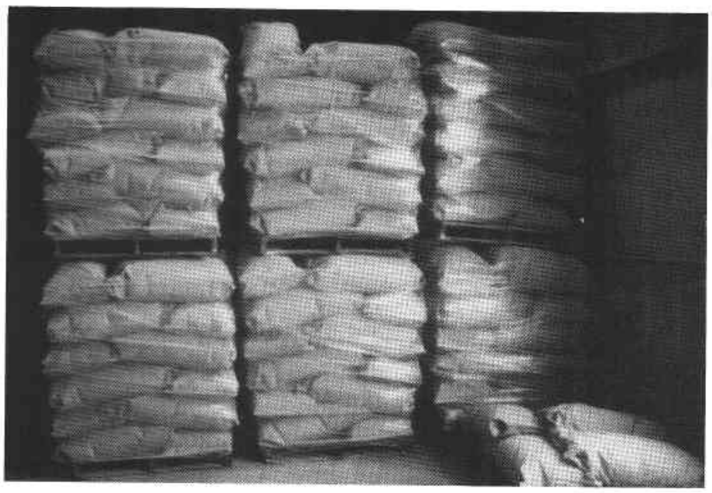

FIGURE 2—Bags of sized pumice, covered with shrink-wrap plastic, on pallets at the American Pumice plant, Santa Fe, ready for loading on rail or truck transport.

New Mexico pumice

Before the Spanish colonial period began in the 16th century, the Bandelier Tuff was used by Native Americans who carved or enlarged caves to form defensible living areas, as in Bandelier National Monument. Most of these openings are on south-facing canyon walls to take advantage of the sun for solar heating and light during colder months of the year. At Puyé Pueblo on the east flank of the Jemez Mountains, tuff and pumice blocks from the Bandelier Tuff were used as building stone.

The Bandelier Tuff is an extensive body of indurated volcanic ash that is thickest on the east and south flanks of the Jemez

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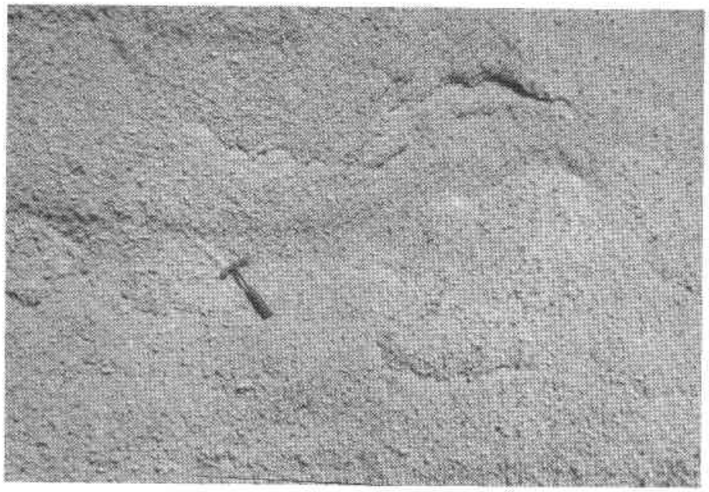

FIGURE 3—A nearly vertical wall of grayish-white Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff in an abandoned mine on the east flank of the Jemez Mountains. Horizontal orientation of the long axis of most pumice clasts is responsible for the indistinct bedding.

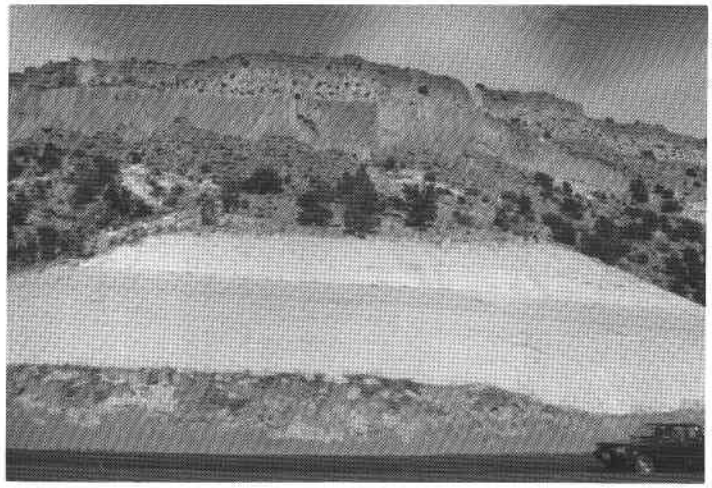

FIGURE 4—Loosely consolidated, light-colored Guaje Pumice Bed of the Otowi Member of the Bandelier Tuff overlain by the welded Tshirege Member at a road cut of NM-4 east of Los Alamos. The Guaje Pumice Bed rests on the irregular upper surface of lava.

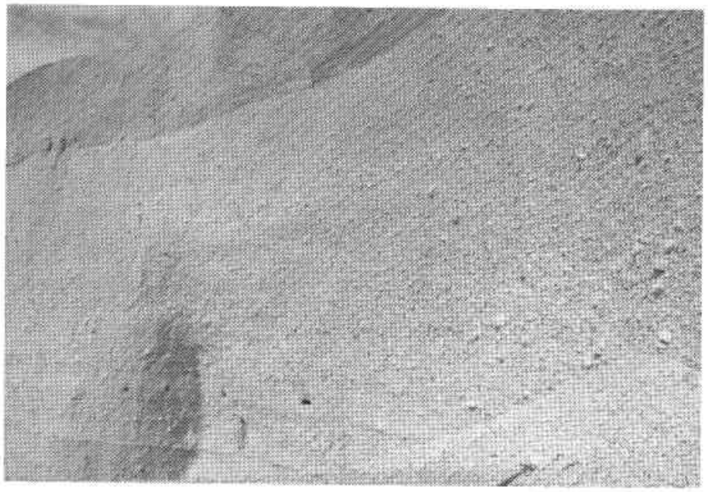

FIGURE 5—Coarse El Cajete pumice in Las Conchas mine near the south rim of the Valles caldera, Jemez Mountains, New Mexico. Note hammer for scale at lower right.

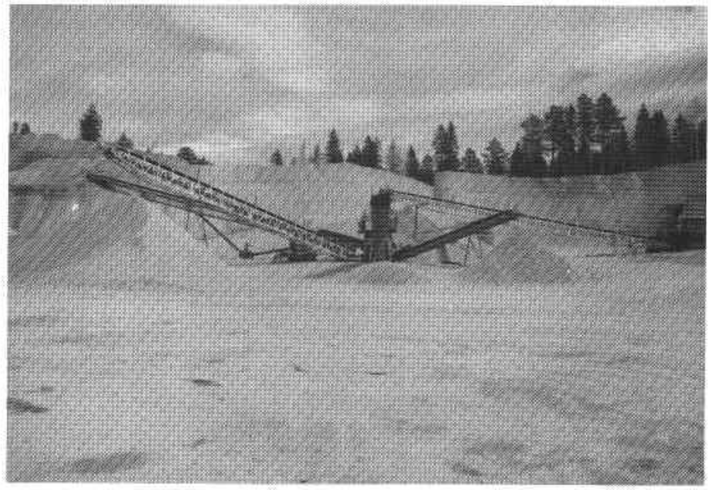

FIGURE 6—Screening plant in Las Conchas mine. Fragments in pile to the left are about fist-size. The pile to the right has fragments two to three times fist-size.

Mountains in north-central New Mexico (Smith et al., 1970). It was deposited from turbulent ash flows originating in the Valles caldera on the crest of the Jemez Mountains. The 1.45-million-year-old (Ma) Guaje Pumice Bed of the Otowi (lower) Member of Bandelier Tuff, ranges from 0 to 9 m thick and averages about 8 m thick in the mined areas (Hoffer, in press). It is only slightly indurated and consists of white pumiceous tuff (Fig. 3). Coarse fragments (>1.9 cm, ">3/4 in.") make up about 5% by weight of the bed. The Tshirege (upper) Member of the Bandelier is indurated and welded; consequently, it is valueless as a source of commercial-grade pumice (Weber, 1965). Most of the caves used by the early Native Americans were developed in the Tshirege Member. Kelley, in an unpublished 1949 company report (reported in Hoffer, in press), estimated the reserves of the Guaje Pumice Bed at approximately 50,000,000 mt near the surface and an additional 1.8 billion mt of pumice below the Tshirege Member of the Bandelier on the northeast part of the Pajarito Plateau (Fig. 4).

Other volcanic units in the Jemez Mountains contain pumice, notably the 0.17 Ma El Cajete Member of the Valles Rhyolite, but only El Cajete Member contains the thick, extensive, near-surface deposits that can be mined easily (Figs. 5 and 6). El Cajete Member ranges from 0 to 75 m thick along the south rim of the Valles caldera (Smith et al., 1970). Commercial pumice with more than 30% very coarse (>1.9 cm) pumice (Hoffer, in press) occurs in beds greater than 25 m thick adjacent to NM-4 (J. W. Hawley, oral communication 1993). Hoffer (in press) estimates El Cajete contains approximately 310,000 mt of minable pumice.

The U.S. Forest Service classifies pumice into two varieties based on fragment size. If pumice has a large amount of material greater than 1.9 cm (">3/4 in."), recent case law has held this to be designated as "uncommon" pumice and thus is considered locatable under the general mining laws (Verity and Young, 1973). This size material ensures that it can be sold for a premium market price for garment finishing, currently as high as $286/mt in the El Paso market area (Hoffer, oral communication 1994). In addition, no royalty fees are required on the pumice. The USFS can not prohibit mining locatable pumice, but it can require such reasonable measures as may be necessary to protect the surface environment. An even larger-size variety, "block" pumice, contains a large proportion of fragments greater than 5 cm (">2 in.") and is also designated "uncommon" or locatable. Common pumice, or nonlocatable pumice, has a larger proportion of material smaller than 1.9 cm and is considered a "mineral material." This designation gives the USFS the discretion to prohibit mining if it is in conflict with other uses of the forest, is publicly controversial, or would affect cultural resources or threatened and endangered species. The Guaje Pumice Bed is considered to be "common" pumice and the Cajete Member of the Valles Rhyolite is considered to contain "uncommon" pumice. ☞

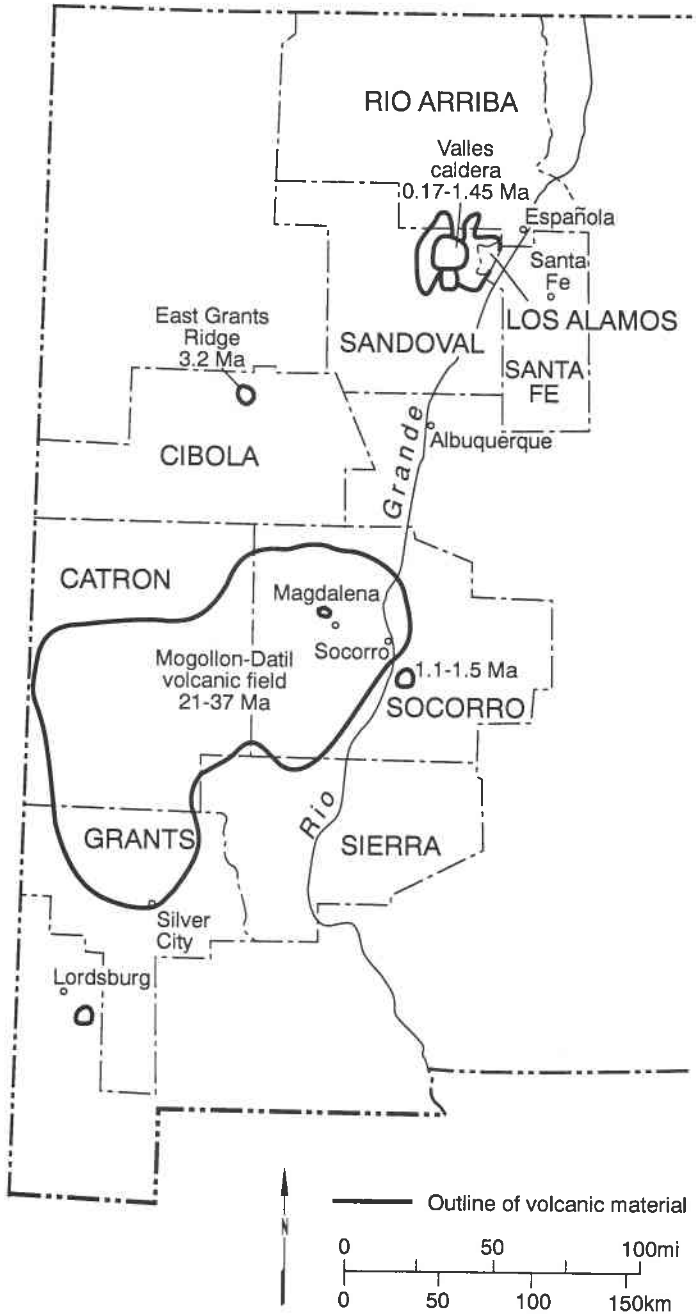

FIGURE 7—New Mexico counties in the west half of the state with mined pumice sites and the location of volcanic materials containing pumice; ages in millions of years (Ma). After Hoffer, in press.

Clippinger and Gay (1947) reported on New Mexico pumice used principally for concrete aggregate. The pumice was shipped to nearby states for use in the construction industry beginning in 1946. Today, Copar Pumice Company of Española, General Pumice Corporation of Santa Fe, and Utility Block Company of Albuquerque have the only active pumice mines in New Mexico (Fig. 7). Copar mines pumice from the Guaje Pumice Bed in the Guaje Canyon mine, secs. 31 and 32 T19N R7E, and from El Cajete Member in Las Conchas mine, sec. 5 T18N R4E (Hoffer, in press). Copar has a screening plant near San Ysidro and a mill at Cuyamungue. General Pumice mines the Guaje Pumice Bed at the Rocky Mountain mine, sec. 34 T21N R7E. Utility Block Company mines the Guaje Pumice Bed in the U.S. Forest Service mine, sec. 3 T17N R3E, for their plant in Albuquerque. The American Pumice Company of Santa Fe has a plant in Santa Fe but buys pumice from General Pumice and other producers rather than mine their own. Reserves of pumice in the Jemez Mountains area are very

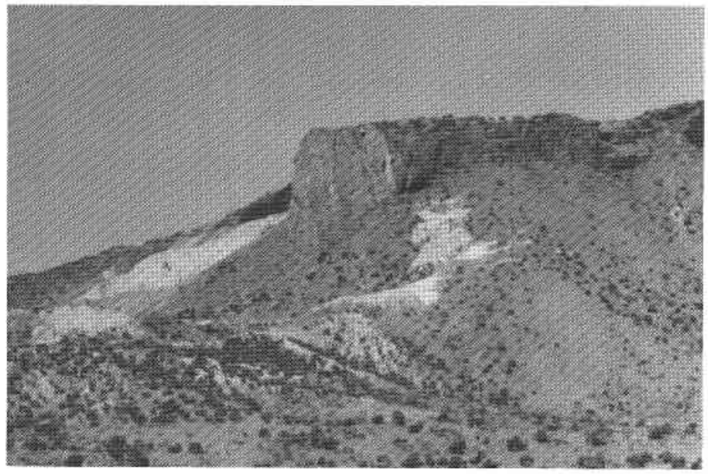

FIGURE 8—Abandoned pumice mine on southeast flank of East Grants Ridge with light-colored pumice below both the dark-colored overburden of scoria and a volcanic cone.

large, but restrictions on mining in scenic and environmentally sensitive areas will reduce the quantity available.

Pumiceous tuff in East Grants Ridge, about 5 mi northeast of Grants, Cibola County, was formerly a source of high-quality abrasive pumice (Weber, 1965; Barker et al., 1989). The tuff consists of lapilli and blocks of pumice along with rhyolite and other rock fragments in a matrix of white ash (Kerr and Wilcox, 1963) in secs. 2, 3, and 11 T11N R9W and sec. 34 T12N R9W. Bassett et al. (1963) assigned an age of 3.2 ± 0.3 Ma to the pumice. Pumice was separated from associated impurities by gravitational methods in the mill at the mine. Large reserves remain at the site, but the 6- to 9-m-thick overburden of dark-colored scoria prevents the use of modern, low-cost, open-pit mining methods to develop the reserves (Fig. 8). During the period from July 1946 to July 1952, a total of approximately 54,000 mt of pumice concentrate was produced from open-pit operations of Pumice Corp. of America. U.S. Gypsum purchased the pumice claims in 1953, but no pumice production has been reported since. Similar pumiceous tuffs in adjacent areas have been described by Hunt (1938), but none has been mined.

Elsewhere in the New Mexico, there has been little development of commercial deposits. Scattered lenses of water-laid lump pumice and pumicite are poorly exposed in low bluffs adjoining the Rio Grande southeast of Socorro, New Mexico. The deposit is about 5 km east–northeast of San Antonio in secs. 27 and 34 T4S R1E (Cather, 1988a; Hoffer, in press). It was deposited from a single flood event of the ancestral Rio Grande that carried material probably expelled in a Jemez eruption 1.1 to 1.5 Ma ago (Cather, 1988b). A bedded pumiceous tuff about 55 km west of Socorro, 7 km northwest of Magdalena, Socorro County, has been tested in small lots. The quality of both these Socorro County deposits is low (Weber, 1965; Hoffer, in press).

The Mogollon–Datil volcanic field in southwest New Mexico consists of lava flows, epiclastic rocks, and pyroclastic units. The latter includes extensive ash-flow tuffs (McIntosh et al., 1991). Pumice is common in rhyolitic tuffs in the sequence, but the commercial quality of these deposits is largely unknown and there are no operating mines in the region. A deposit south of Lordsburg, Hidalgo County, was a source of small amounts of pumice aggregate mined by Kirk's Perlite Industries in 1950 (Weber, 1965).

Environmental concerns in pumice mining

Much of New Mexico's pumice is on federal land. The deposits on the south and east flanks of the Jemez Mountains lie in the Santa Fe National Forest, with lesser amounts on lands of the Santa Clara and Jemez Pueblos, and on State of New Mexico lands. No mining is allowed in Bandelier National Monument or the several wilderness areas or other withdrawals in the Santa Fe National Forest.

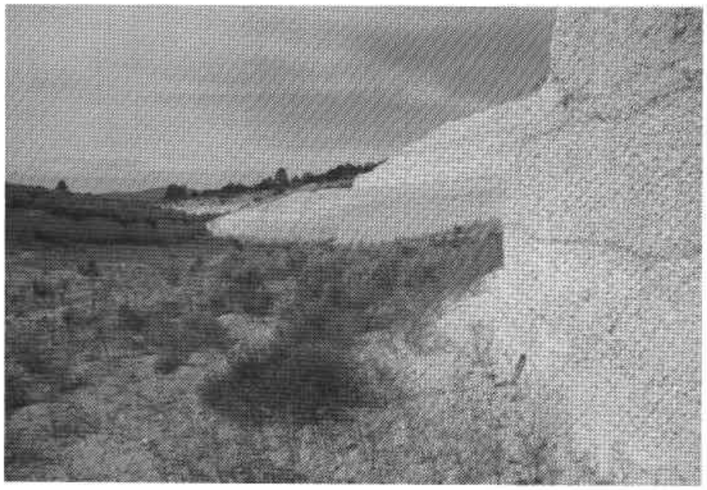

FIGURE 9—High wall of a pumice mine on the east flank of the Jemez Mountains abandoned before reclamation was required. The mine was abandoned when the overburden became to thick to be removed before the high-grade white pumice could be mined. The mine was abandoned 20 to 25 years ago.

FIGURE 10—Natural revegetation of the flat areas in the same abandoned pumice mine as in Fig. 9. Note the high wall with no vegetation in the background.

Mining on USFS land

To open a pumice mine on available U.S. Forest Service (USFS) land at the present time requires a number of steps. One of the first is an operating plan submitted for review to the USFS outlining the activities of the company or individual from preliminary work before mining begins, through completion of reclamation and seeding of the surface. Proposals are analyzed for possible environmental impacts as mandated by the National Environmental Policy Act (NEPA). The operating plan is the proposed plan of action whereas the environmental impact document explores the effects of mining and develops alternatives actions if necessary.

The operating plan must detail such things as: the future of both the trees and soil that overlie the proposed site; the necessity of new roads to remove the pumice, and if so, the provenance of the road fill. The environmental analysis describes the effect of the heavy machinery necessary to construct roads and expose the pumice, as well as the influence of trucking pumice on existing roads, and the impact on scenic aspects of the area; the consequence the mine activities will have on runoff into streams; the effect of mine dust on the area; and protection of livestock in the area from adverse results of mining. Another aspect that can be considered in pumice mining is the effect of removal of the pumice on aquifer recharge in an area.

Some of the intermediate events or milestones considered in the operating plan include: (1) An archeological examination by a certified archeologist to established the existence or absence of prehistoric or historical artifacts or features. If such cultural features or artifacts are found and are important, mining is modified or prohibited because these resources must be protected. Such sites may be avoided by changes in the operating plan or by "mitigation by removal and interpretation." (2) A biological survey must be conducted to ensure the proposed activity will not adversely impact either "threatened and endangered" (T&E) wildlife and plant species listed by the U.S. Fish and Wildlife Service or the New Mexico Game and Fish Department, or species identified by the Southwest Regional Forester. Habitat critical for these "sensitive" species can not be altered. In the Jemez Mountains, the Jemez Mountains salamander has been proposed for T&E listing and protection, pending additional studies, and the wood lily has been classified as sensitive by the Regional Forester. If the pumice to be mined is classified as "common" (composed principally of fragments smaller than 1.9 cm), T&E species and/or archaeological finds in the mining area can mean that mining is prohibited. More often, the operating plan is modified to incorporate additional protective measures identified in the environmental analysis.

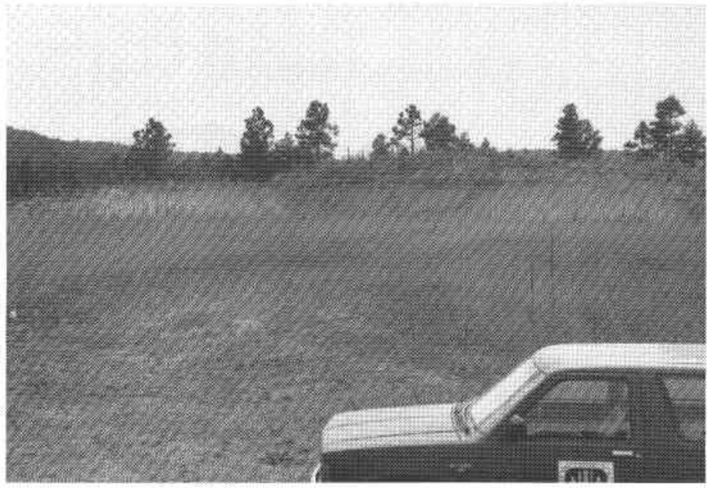

FIGURE 11—Reclaimed section of the Utility Block pumice mine east of Jemez Springs on the south flank of the Jemez Mountains. The grassed area was reclaimed and seeded about 2 years ago.

NEPA does not specify that the environmental surveys must be performed as a requirement in the operating plan, only that the plan incorporate any mitigating procedure identified in the environmental analysis. Fulfilling NEPA requirements is the responsibility of, in this case, the U.S. Forest Service, not the mining company. However, to speed up the process, the company will often hire a third party to prepare the NEPA documents, such as performing the surveys and writing up the documentation. The third party can involve many people, none of whom can be engaged in the extraction of the resource, and therefore the mining company can not recoup the expense until the mine begins to operate. This may not be until months and sometimes years after the initial decision of the company that it wishes to mine the area; delays are common. Such initial expense may place the proposed mine beyond the resources of many operators, particularly small local companies.

Public involvement in determining whether a plan of operation will be approved includes the USFS contacting agencies, individuals, and groups that have indicated in the past that they wish to be involved with the NEPA process. If the public indicates an interest in the project, public meeting(s) are held to clarify issues.

Monitoring the mining operation is required when a plan of operation is approved by the USFS. Periodic checks determine compliance with the rules and conditions as given in the oper- ☞

ating plan. Release of the reclamation bond, which had been posted before mining commenced, and final release of the mining concern from its obligations, as outlined in the operation plan, comes only after all reclamation has been completed.

Competition for commercial pumice mining in north-central New Mexico

Although New Mexico's commercial pumice deposits occur principally in a sparsely populated area of the Jemez Mountains, the area also is used extensively by hikers and campers, as well as lumbering operations. The tourist industry is vital to New Mexico's economy. This means that mining must compete with many other interests for the right to mine. In the past, reclamation was not required, and pits were abandoned without reducing the highwalls or replacing the soil. In some cases, highly visible scars were left in the forest cover (Fig. 9). In practice, all abandoned pumice pits are eventually revegetated by nature (Fig. 10), but reclamation greatly speeds up the process.

The effects of past mining of pumice in the Jemez Mountains are sometimes hard to find, especially in areas of recent reclamation (Fig. 11), but some highwalls in abandoned mines are still present and expose pumice below an overburden that was too thick to remove. After reestablishment of the vegetative cover, little will remain of past mining operations, except for roads and trails used by hikers, campers, and other visitors to the area.

A balanced approach that recognizes both the need for minerals and the need to protect lands and forests is required whereby pumice mining can occur under controlled conditions. Access by all other responsible interests who need the use of public land must also be considered.

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Needed
Volunteers for summer scouting programs

Out-going, young-at-heart geologists, mining engineers, mine inspectors, or reclamation specialists willing to donate a week or more are needed to work with America's youth at: Trefoil Ranch, Provo Canyon, Utah; Camp Elliott Barker, Angel Fire, New Mexico; Philmont Scout Ranch, Cimarron, New Mexico.

Recruits are again being sought from the retired and still-active educational, federal, state, and industrial sectors for BLM's 1994 summer volunteer programs.

The Sangre de Cristo Girl Scout Council is again specifically seeking "role model" female professionals at Camp Elliott Barker. The Utah Girl Scout Council similarly will use "role models" from the minerals professions at Trefoil Ranch near scenic Provo Canyon. Rocks and fossils are favorite topics.

Philmont Scout Ranch participants will spend their time in the back county sharing professional insights, geologic interpretations, mine history, and career counselling. Warm bedrolls, rain gear, a spirit of adventure, and the ability to rap informally around a campfire and on the trail with teenagers are essential tools of the trade.

The respective scout organizations provide food and lodging. This provides not only for a great family outing but a chance for our professionals to alert America's youth to the fact that minerals are still essential to our nation's economic well being.

For additional information, contact Stu Carlson, Minerals Outreach Coordinator, Bureau of Land Management, 324 South State, Suite 301, Salt Lake City, Utah 84111-2303 (801/539-4244).