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OUTLINE OF THE IGNEOUS GEOLOGY OF THE JEMEZ MOUNTAINS VOLCANIC FIELD

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INTRODUCTION

Our knowledge of the volcanic history of the Jemez Mountains is derived mainly from the extensive work by U.S. Geological Survey geologists—in particular, C. S. Ross, R. L. Smith, and R. A. Bailey. Publications by Ross and others (1961), Bailey and others (1969), Smith and Bailey (1966, 1968), and Smith and others (1970) are used in this discussion, and their data have been summarized here.

In early Pliocene time, volcanic activity was initiated from many centers in the Jemez Mountains with eruptions of dominantly mafic to intermediate flows, which probably formed low, coalescing shields. This activity culminated in the early Pleistocene with explosive, caldera-forming eruptions of ash-flow tuffs, which covered most of the shields and formed two calderas, the largest and youngest of which is the Valles caldera (Fig. 1). The older Toledo caldera is poorly exposed to the northeast of the Valles caldera. Subsequent eruptions were restricted within the Valles caldera, resulting in caldera-fill, and doming of the caldera floor, forming Redondo Peak. Rhyolite domes emerged along ring fractures within the moat between the resurgent dome and the caldera wall.

VOLCANIC HISTORY

The volcanic rocks erupted during the pre-caldera phase have been divided into two stratigraphic groups: the Keres Group in the southern part of the Jemez Mountains and the Polvadera Group exposed in the northern part. The older group appears to be the Keres, as one of its members has been dated by the K-Ar method to be at least 8.5 m.y. The Polvadera Group ranges in age from 7.4 to 2.0 m.y.

The Keres Group is subdivided into four formations from oldest to youngest: Basalt of Chamisa Mesa, Canovas Canyon Rhyolite, Paliza Canyon Formation, and the Bearhead Rhyolite-Peralta Tuff Member (Table 1). The Basalt of Chamisa Mesa is exposed about 6 km east of Jemez Pueblo, where it overlies early Pliocene Santa Fe Formation. It is composed of olivine basalt in thin multiple flows. The Canovas Canyon Rhyolite occurs as volcanic domes, shallow intrusives, flows, and bedded tuffs. The rhyolite is commonly aphyric, but if phenocrysts are present, they include biotite, sanidine and quartz. Exposures of these rhyolites are best seen near Bear Springs. The Paliza Canyon Formation is best exposed around the caldera rim and especially south of the Valles caldera. Some Paliza Canyon Formation is found within the caldera. It is composed of olivine-augite basalt flows, hypersthene-augite andesite flows, breccias, and dikes, and of coarsely porphyritic dacite, rhyodacite, and quartz latite flows. The Bearhead Rhyolite occurs as flows, domes, and shallow intrusives cutting the Paliza Canyon Formation in the vicinity of Bearhead Peak. Poorly consolidated sand and gravel derived from the Keres Group have been named the Cochiti Formation, which is best exposed under Santa Ana Mesa.

The northern Polvadera Group has been subdivided into the Lobato Basalt, Tschichoma Formation, and the El Rechuelos Formation. The oldest formation, the Lobato Basalt, occurs as flows composed of olivine-augite basalt. The best exposures are on Lobato Mesa north of Santa Clara Ranger Station. The Tschichoma Formation is exposed extensively outside the north and east rim of the Valles caldera. It is composed of coarsely porphyritic dacite, rhyodacite, quartz latite flows and domes. The phenocrysts are pyroxene, hornblende, biotite and plagioclase, with minor quartz. The El Recheulos Rhyolite occurs as isolated domes composed of pumice, perlite, and obsidian overlying the Tschichoma north of the Valles Caldera. During the activity of Polvadera Group, extensive volcanic debris accumulated as conglomerates and coarse sands interbedded with lithic lapilli tuffs and lahar deposits in the area west of Espanola. These volcaniclastics composed predominantly of debris from the Tschichoma Formation have been called the Puye Formation. The basaltic lavas of Santa Ana Mesa and Cerros del Rio were also erupted during this time.

The caldera formation was initiated in early Pleistocene time with the eruption of the Bandelier Tuff Formation of the Tewa Group. There are two members in the Bandelier Tuff, each consisting of a basal pumice bed overlain by a nonwelded to densely welded ash-flow tuff unit containing bipyramidal quartz and chatoyant sanidine phenocrysts. The oldest member is the Otowi Member, which was erupted from the area northeast of the Valles caldera in the vicinity of Sierra de los Valles. The eruption of the Otowi Member resulted in the formation of the Toledo caldera, which was about 9 km in diameter. The eruption of the younger Tshirege Member (about 1.1 m.y. ago) resulted in the formation of the larger (22 km in diameter) Valles caldera, which cuts and obscures the Toledo caldera.

After caldera collapse, magmatic activity was renewed and rhyolite was intruded along ring fractures around the calderas. Around the Toledo caldera, the rhyolite was extruded as volcanic domes, one of which occurs south of Highway 4 along the border of Valle Grande. This rhyolite is called the Cerro Toledo Rhyolite. The younger Cerro Rubio Quartz Latite, with phenocrysts of biotite and hornblende, intrudes and overlies the Cerro Toledo Rhyolite as a volcanic dome.

After collapse of the Valles caldera, renewed magmatic activity occurred with extensive rhyolitic eruptions (Valles Rhyolite Formation of the Tewa Group), emanating mainly from a ring fracture within the caldera. Some of the early Valles Rhyolite eruptions flowed into the caldera before more rhyolite magma upwarped the caldera center into a resurgent dome forming Redondo Peak. Hence most of the rocks exposed in the resurgent dome are those rocks which predom-

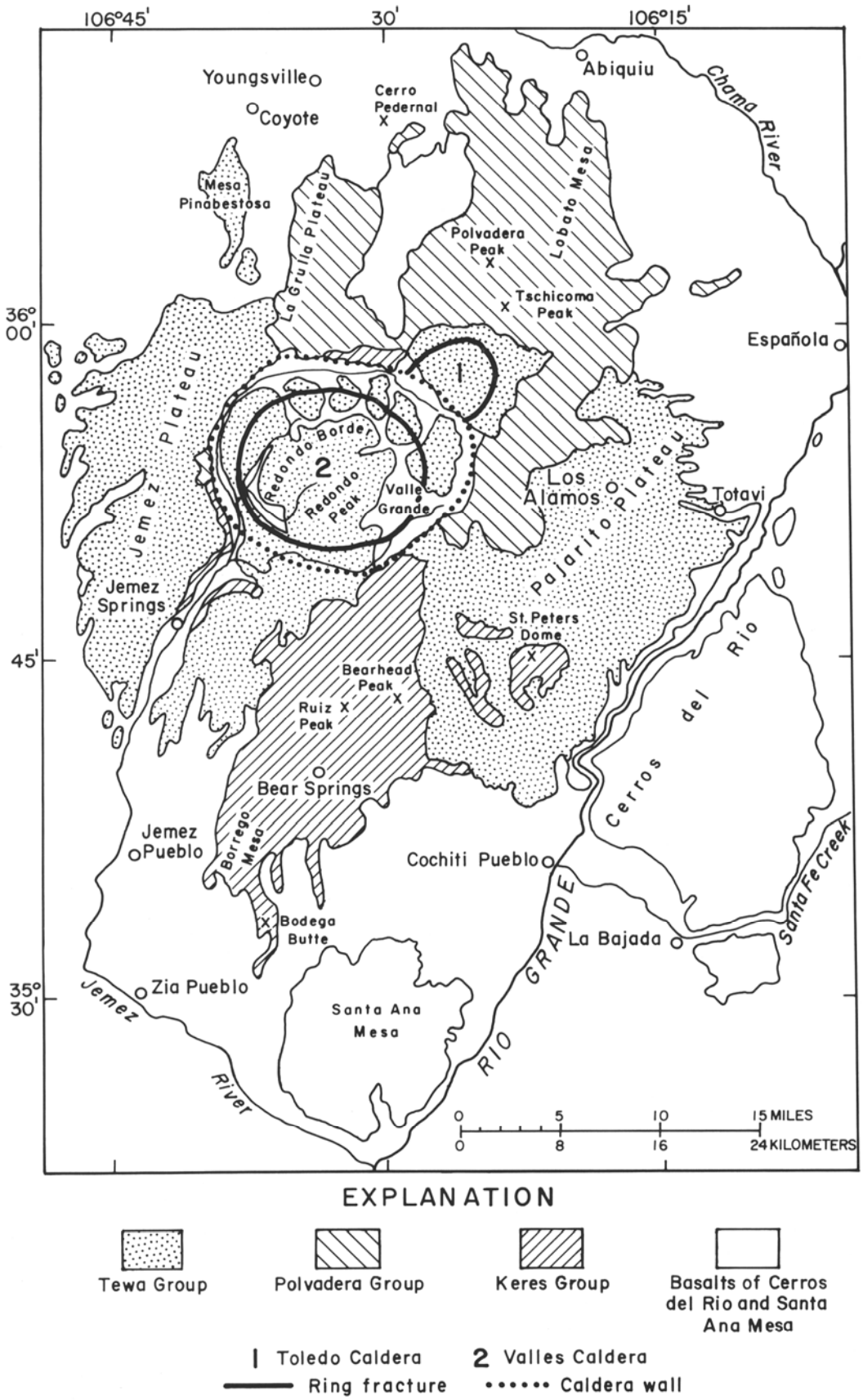

Figure 1. Generalized map of the Jemez Mountains, New Mexico. (Adopted from Bailey and others, 1969).

Table 1. Nomenclature of the volcanic and related rocks of the Jemez Mountains. (Adapted from Bailey and others, 1969).

Age	Group	Formation and brief description		
Pleistocene	Tewa Group	Valles Rhyolite	Banco Bonito Member (vitrophyre, flow) El Cajete Member (bedded air-fall deposits, rhyolite pumice blocks and lapilli) Battleship Rock Member (rhyolite ash-flow tuff) Valle Grande Member (porphyritic rhyolite domes, flows, and tuffs) Redondo Creek Member (quartz-poor rhyolite dome, dike, flow, tuffs) Deer Canyon Member (rhyolite dome-flows)	
		Cerro Rubio Quartz Latite (biotite-hornblende quartz latite, intrusion dome)	Bandelier Tuff	Tshirege Member (ash-flow tuff, inclusions of hornblende-rich quartz-latite pumice; basal air-fall pumice, "Tsankawi Pumice Bed")
		Cerro Toledo Rhyolite (quartz-poor, domes, tuffs)		
				Otowi Member (ash-flow tuff, lithic inclusions; basal air-fall pumice, "Guaje Pumice Bed")
Late Pliocene	Polvadera Group	El Rechuelos Rhyolite (pumice, perlite, obsidian; volcanic domes and cone) Tshicoma Formation (porphyritic dacite, rhyodacite, quartz latite; massive flows and domes) Lobato Basalt (olivine-augite basalt, flows)	Puye Formation (conglomerate, coarse sands, interlayered lithic lapilli tuff beds and lahar deposits; debris predominantly from contemporaneous erosion of the Tschicoma Formation; can have Precambrian debris and interlayered lake clays)	
Middle Pliocene	Keres Group	Bearhead Rhyolite-Peralta Tuff Member (rhyolite domes, intrusions, flows, and tuffs) Paliza Canyon Formation (basaltic andesite, andesites; flows, breccias, dikes; also porphyritic dacites to quartz latites) Canovas Canyon Rhyolite (domes, intrusions, flows, and tuffs) Basalt of Chamisa Mesa (olivine basalt flows)	Cochiti Formation (sand and gravel, poorly consolidated; debris predominantly from erosion of the Keres Group; granitic detritus increases southward)	
Early Pliocene				

inantly were caldera-fill Bandelier Tuff, some of the early post-caldera rhyolite flows, and clastic caldera fill. Some Paliza Canyon Formation is also exposed.

The Valles Rhyolite is subdivided into six members which include from oldest to youngest: the Deer Canyon Member, the Redondo Creek Member, the Valle Grande Member, the Battleship Rock Member, the El Cajete Member and the Banco Bonito Member. The first two members erupted as rhyolite domes and flows prior to the resurgent doming, which occurred possibly during the eruption of the Valle Grande Member. The volcanic domes and flows of the Valle Grande Member occur in the moat formed between the caldera wall and the resurgent dome. The Valle Grande rhyolites have abundant phenocrysts of quartz and sanidine and have been dated by Doell and others (1968) by the K-Ar method to be from 1.0 to 0.4 m.y. old.

The youngest members of the Valles Rhyolite probably erupted from El Cajete crater on the south side of the Valles caldera. The Battleship Rock Member is a nonwelded to partly welded ash-flow tuff composed of rhyolite ash and pumice, with phenocrysts of quartz, sanidine, plagioclase, hornblende, and pyroxene. This member is confined to the uppermost Canon de San Diego. The El Cajete Member (older than 42,000 years B.P.) is composed of well- to crudely-bedded air-fall deposits of rhyolitic pumice blocks and lapilli. A thick flow of vitrophyre, containing phenocrysts of quartz and feldspars and belonging to the Banco Bonito Member, overlies the Battleship Rock Member in the uppermost Canon de San Diego.

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