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DEVELOPMENTS IN THE CENOZOIC VOLCANIC STRATIGRAPHY OF THE INDIAN PEAKS AREA, NORTHERN BLACK RANGE, NEW MEXICO

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Abstract—The Indian Peaks in the northern Black Range are an erosional remnant of a dome–flow complex of Taylor Creek Rhyolite. The rhyolite dome–flow complex is interbedded with and overlain by regional ash-flow tuffs and local pyroclastic deposits. Recent detailed studies in the Indian Peaks area have demonstrated that the Taylor Creek Rhyolite can be separated, with some difficulty, into four dome–flow complexes or phases. Detailed work has also shown that the ash-flow tuffs, originally lumped as one unit and called Railroad Canyon Rhyolite, actually consist of two regional tuffs, Bloodgood Canyon Tuff and Shelley Peak Tuff, as well as locally derived ash-flow tuffs.

INTRODUCTION

Indian Peaks are the erosional remnant of a middle Tertiary rhyolite dome–flow complex in the northern part of the Black Range in Catron County, New Mexico. The Black Range trends approximately north–south along the eastern margin of the Mogollon Plateau, a relatively stable tectonic block northeast of the Basin and Range, south of the Colorado Plateau and west of the Rio Grande rift (Fig. 1). This paper deals principally with the stratigraphy and nomenclature of layered volcanic rocks in the Indian Peaks area; however, much of the stratigraphy applies over a much broader area, especially the stratigraphy of the regional ash-flow tuffs.

The geology of the area was previously described by Fries & Butler (1943), Elston et al. (1970, 1973, 1976), and Fodor (1976). The early investigations of Fries & Butler (1943) concentrated chiefly on the rhyolite dome–flow complexes and their relationship to the associated tin deposits; no attempt was made to separate the many pyroclastic deposits in the area. Elston (1968) named the rhyolite the Taylor Creek Rhyolite and Elston et al. (1970) gave the name Railroad Canyon Rhyolite to a moonstone-bearing ash-flow tuff exposed in Railroad Canyon, and speculated that the source was a shallow topographic depression referred to as the Corduroy Canyon depression. Rhodes & Smith (1972) studied the directional fabric of the tuff and further developed the idea of the Corduroy Canyon depression. Elston et al. (1973) recognized that the rhyolite at Indian Peaks was younger than the bulk of the Taylor Creek Rhyolite. When Fodor (1976) mapped in the area, he extended the mapping of Fries & Butler (1943) to the north and followed the terminology of Elston et al. (1970, 1973), but did not attempt any detailed studies.

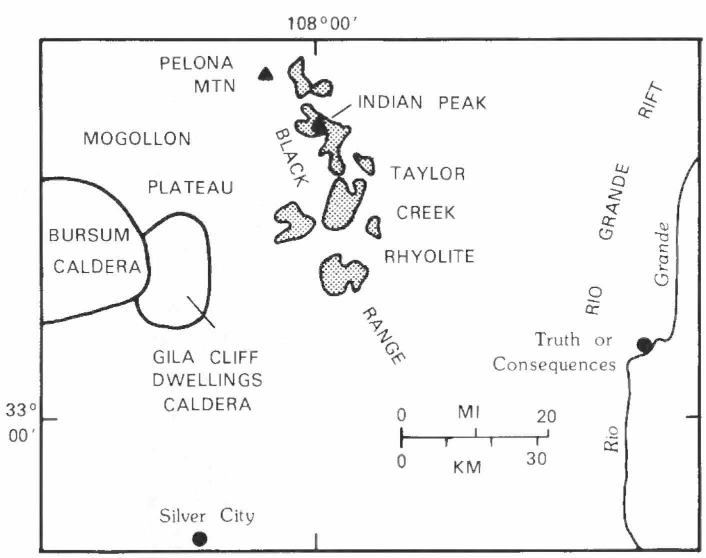

FIGURE 1—Map showing location of Taylor Creek Rhyolite. Caldera outlines are from Ratté et al. (1984).

In this report, based on a topical study of the rhyolite at Indian Peaks (Lawrence 1985) and detailed geologic mapping (Lawrence & Richter 1986, Richter et al. 1986), it is concluded that the Railroad Canyon Rhyolite of Elston et al. (1970) is composed of both regional ash-flow tuffs—Bloodgood Canyon and Shelley Peak Tuffs—and locally derived pyroclastic deposits. Hence the term Railroad Canyon Rhyolite should be dropped and the need of a source caldera is alleviated.

FLOW-BANDED RHYOLITES

The Taylor Creek Rhyolite was originally mapped by Fries & Butler (1943) as a single unit. Major-element chemistry indicates that the rocks are high-silica and high-potassium, peraluminous, alkali-feldspar rhyolites, and it appears that individual phases cannot be distinguished by their major-element chemistry (Lawrence & Richter 1986, Richter et al. 1986). However, detailed mapping combined with minor-element chemistry (Lawrence 1985) has shown that the Taylor Creek Rhyolite can be split into separate dome–flow complexes, even though they are very similar.

In the Indian Peaks area, geologic field studies have shown that the Taylor Creek Rhyolite is actually four separate phases or rhyolite dome–flow complexes (Figs. 2, 3). From south (Corduroy Canyon) to north

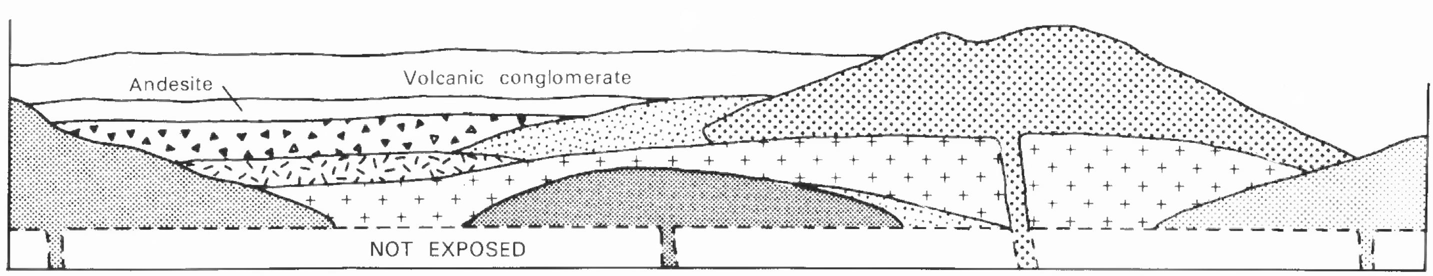

FIGURE 2—Schematic stratigraphic section showing relationships of the four Taylor Creek Rhyolite phases and ash-flow tuffs in the Indian Peaks area. Unit patterns are the same as Figure 3.

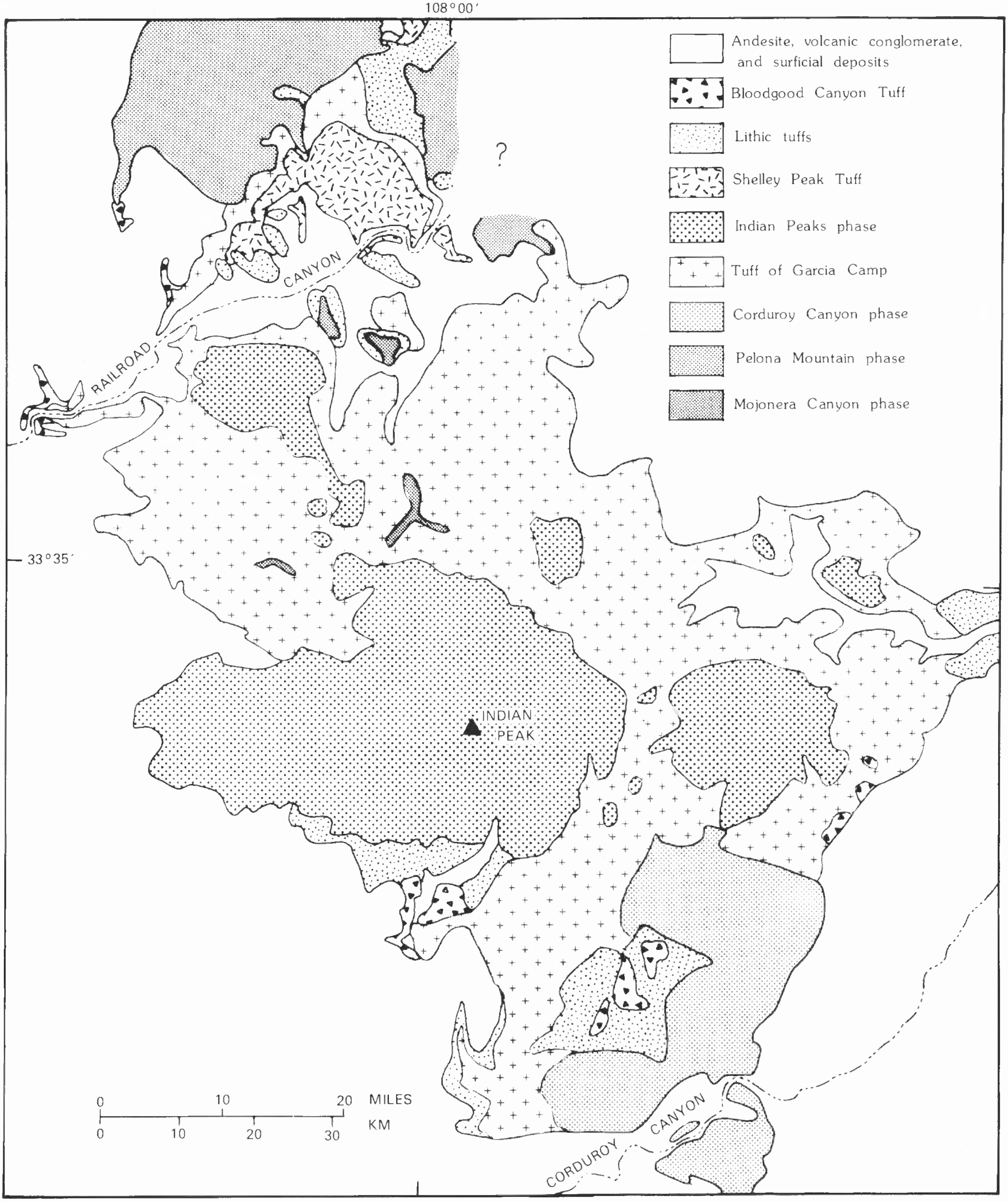

FIGURE 3—Generalized geologic map of Indian Peaks area showing four phases of Taylor Creek Rhyolite and ash-flow tuffs. Geology from Lawrence and Richter (1986), Richter et al. (1986), and Lawrence (unpublished data).

(east of Pelona Muntain) they are: Corduroy Canyon phase (which may include more than one dome–flow complex), Indian Peaks phase, Mojonera Canyon phase (referred to as the older phase by Lawrence & Richter 1986), and Pelona Mountain phase.

There is some variation in crystal content of the individual rhyolite phases, which is helpful in differentiation of some phases, but in general all phases are megascopically similar and cannot be separated on the basis of macromineralogy alone with certainty. The Corduroy Canyon phase consists of an average of 10% quartz, 12% sanidine, and traces of plagioclase and opaque minerals. The Indian Peaks phase is fairly similar, with an average of 9% quartz, 11% sanidine, and traces of plagioclase and opaque minerals. The northern two phases are comparatively crystal-poor. The Mojonera Canyon phase averages 1% quartz, 3% sanidine, and a trace of opaque minerals, and the Pelona Mountain phase averages 1% quartz, 6% sanidine, and a trace of opaque minerals.

Selected minor-element chemistry for a number of the rhyolites is given in Tab. 1, and a ternary plot of rubidium, zirconium, and niobium is shown in Fig. 4. These three elements, which are generally unaffected by either devitrification or alteration, appear to nicely separate some of the rhyolite phases in the Indian Peaks area into distinct groups. The principal difference between the phases is in their Rb:Zr ratios which range from about 2:1 in the Indian Peaks phase to almost 1:2 in the Pelona Mountain phase. The Mojonera and Corduroy Canyon phases fall between these two extremes; however, the Corduroy Canyon phase lacks sufficient data. Duffield (1986) is currently studying the overall Taylor Creek Rhyolite field and also finds that differences in Rb, Nb, and Ba may be useful discriminants in distinguishing between various dome–flow rhyolites.

TABLE 1—Minor element anayses, in ppm, for phases of Taylor Creek Rhyolite in Indian Peaks area. Analyses by energy dispersive x-ray fluorescence (KEVEX), analyst V.A. Lawrence. Leaders indicate no analyses, nd indicates a value below minimum detection limit.

Sample no.	Location	Zn	As	Rb	Sr	Y	Zr	Nb	Mo	Sn	Ba	La	Ce
Minimum detection limit		30	13	6	6	5	4	3	4	9	6	6	7
					Corduroy Canyon phase								
83-Rh-50	33°31′15″ 107°58′15″	41	nd	315	33	109	169	43	nd	nd	69	59	128
V-143	33°32′55″ 107°58′15″	57	32	270	9	105	211	46	12	nd	70	62	146
V-158	33°31′35″ 107°58′10″	60	24	270	9	81	227	47	8	10	72	81	153
					Indian Peaks phase								
V-3	33°36′15″ 108°01′55″	47	28	336	nd	86	153	51	nd	nd	33	60	123
V-24	33°35′50″ 108°01′10″	64	nd	305	10	58	160	30	5	nd	104	57	152
V-77	33°33′45″ 108°00′45″	56	17	411	nd	30	142	38	8	nd	18	33	77
V-89	33°36′35″ 108°01′15″	49	nd	399	nd	97	161	40	4	nd	46	64	123
V-90	33°36′30″ 108°01′15″	71	nd	397	nd	27	146	40	9	nd	30	31	83
V-97	33°35′05″ 107°58′55″	48	nd	404	nd	50	154	41	6	nd	27	30	112
V-102	33°33′10″ 107°58′55″	59	15	418	nd	60	151	39	7	nd	28	73	124
V-103	33°33′05″ 108°00′00″	87	13	406	nd	112	145	38	5	nd	10	57	127
V-106	33°34′10″ 107°58′35″	47	nd	417	nd	33	147	35	nd	nd	34	34	110
V-119	33°34′15″ 107°57′50″	56	nd	304	nd	29	149	30	6	nd	44	52	116
V-121	33°33′50″ 107°57′15″	59	21	407	nd	101	153	41	5	nd	24	61	128
					Mojonera Canyon phase								
V-41	33°35′20″ 108°00′00″	107	22	286	8	73	224	36	4	nd	29	52	124
V-41B	33°35′20″ 108°00′00″	96	29	272	nd	71	215	46	8	10	18	44	120
V-52	33°36′35″ 108°00′30″	90	14	283	nd	78	210	40	52	10	20	50	98
V-53	33°36′30″ 108°00′25″	79	14	302	nd	37	216	38	5	38	21	42	66
V-91	33°36′45″ 108°01′00″	91	29	253	15	77	212	51	8	12	43	54	105
					Pelona Mountain phase								
85-VL-50	33°38′00″ 108°02′50″	30	nd	152	11	61	164	29	6	--	--	--	--
85-VL-51	33°37′45″ 108°02′50″	34	nd	235	nd	90	348	37	nd	--	--	--	--
85-VL-53	33°57′55″ 108°02′20″	58	nd	235	nd	86	356	37	8	--	--	--	--
85-VL-56	33°38′20″ 108°02′10″	55	nd	233	nd	55	355	37	5	--	--	--	--
85-VL-57	33°38′05″ 108°01′35″	54	nd	209	nd	76	338	36	5	--	--	--	--
85-VL-59	33°38′25″ 108°01′25″	34	nd	210	15	92	364	36	4	--	--	--	--
85-VL-77A	33°38′40″ 108°00′05″	61	24	210	nd	75	349	34	6	--	--	--	--
85-VL-77B	33°38′40″ 108°00′05″	63	nd	210	nd	96	345	35	nd	--	--	--	--
85-VL-91	33°39′50″ 108°00′10″	nd	13	336	nd	94	148	46	4	--	--	--	--

ASH-FLOW TUFFS

The rhyolites are interbedded with and overlain by several ash-flow tuffs and pyroclastic deposits that were grouped together and called the Railroad Canyon Rhyolite by Elston et al. (1970). We now know from detailed mapping that the Railroad Canyon Rhyolite in the Indian Peaks area actually consists of two regional tuffs, the Bloodgood Canyon Tuff and the Shelley Peak Tuff, which overlie the Taylor Creek Rhyolite, as well as at least two local pyroclastic-flow deposits, the tuff of Garcia Camp and several local lithic- and pumice-rich tuffs (units Toc and Tlp), which are interbedded with the dome–flow rhyolites (Figs. 2, 3).

The Bloodgood Canyon Tuff, 28–29 my old, is the caldera-collapse tuff of the Bursum caldera southwest of the Indian Peaks (Ratté et al. 1984). The Bloodgood Canyon Tuff overlies both the Shelley Peak Tuff and the tuff of Garcia Camp. The contact of the Bloodgood Canyon Tuff overlying the tuff of Garcia Camp is well exposed on the north side of Railroad Canyon about 4.5 km west of Garcia Camp, near the type locality of the Railroad Canyon Rhyolite.

The Bloodgood Canyon Tuff is light gray to light brownish gray and crystal poor, containing 6–7% chatoyant sanidine, 1% quartz, and traces of biotite, hornblende, and sphene. The groundmass consists largely of devitrified glass shards. Maximum thickness in the area is 30 m.

The Shelley Peak Tuff, about 30 my old, also of regional extent, has been suggested to have been erupted from the Gila Cliff Dwellings caldera (Ratté et al. 1983). The Shelley Peak Tuff was not initially recognized as such during mapping in the Indian Peaks area and was called the "Pyroxene-bearing ash-flow tuff" (Lawrence & Richter 1986, Richter et al. 1986). However, later discussions and field examinations with J. Ratté (USGS) indicated that the pyroxene-bearing tuff was probably the same as the Shelley Peak Tuff.

The tuff is light gray to pinkish gray, with about 20% total crystal content including 10–12% sodic plagioclase, 4–5% sanidine, 2% bio-

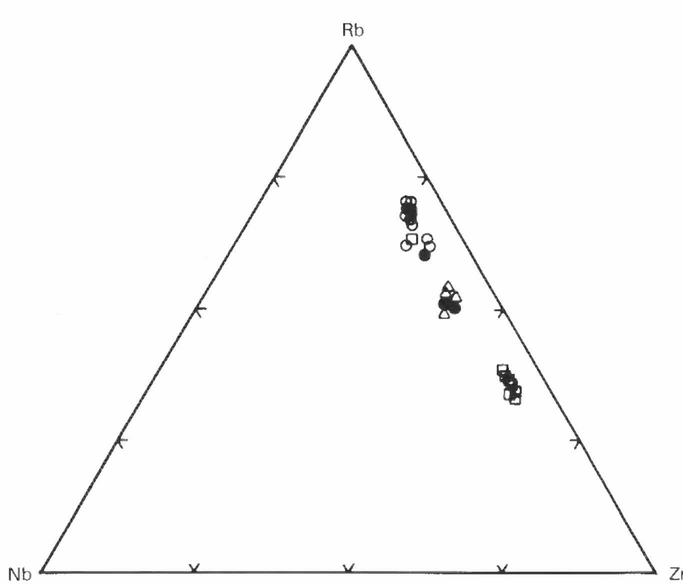

FIGURE 4—Ternary plot of Rb-Nb-Zr for four phases of Taylor Creek Rhyolite. Open circles—Indian Peaks phase, triangles—Mojonera Canyon phase, squares—Pelona Mountain phase, solid dots—Corduroy Canyon phase.

tite, 1% clinopyroxene, and traces of quartz and opaque minerals in a largely devitrified, shard-rich matrix. The maximum thickness in the area is about 5 m.

The tuff of Garcia Camp was named after good exposures in the area of Garcia Camp, part of the Adobe Ranch (Lawrence 1985). The tuff is locally derived and forms a crude cone upon which the rhyolite of Indian Peaks was extruded.

The tuff of Garcia Camp is pale red purple to light brownish gray and contains an average of 20% phenocrysts. However, there is a large amount of variation in phenocryst content, due in part to the degree of compaction of the rock. Microfractured quartz (11%) and sanidine (8%) constitute nearly all of the phenocrysts, along with traces of opaques and plagioclase. There are almost no mafic phenocrysts in the tuff. The groundmass consists of a very fine-grained quartz and potassium feldspar derived from the devitrification of glass shards, which are no longer visible. The rock contains locally flattened pumice blocks, up to a meter in diameter, with the same mineralogy as the groundmass. The tuff also contains lithic rhyolite fragments, up to 3 cm in diameter, similar to the Indian Peaks phase of the Taylor Creek Rhyolite. The tuff commonly weathers to rounded ciffs containing numerous caverns and consists of thin (0.5 m) to thick (20 m) individual pyroclastic flows which are generally gently dipping, except on the eastern edge of the Indian Peaks, where dips reach 18°. In places the tuff is interbedded with monolithologic rhyolite breccia probably from hot debris flows. Maximum thickness is 150 m, although the base is generally not exposed.

Locally derived pyroclastic flows and volcanic sandstones of varying age constitute the remainder of the bedded volcanic rocks in the area. Most of these are lithic- and pumice-rich ash flows that apparently represent products of the last volcanic activity from the Indian Peaks dome–flow complex. The tuffs are discontinuous and overlie the tuff of Garcia Camp and, in some places, the rhyolite of Indian Peaks phase. The tuff is commonly associated with finely bedded volcanic sandstones that show nice crossbedding and may be pyroclastic-surge deposits. An older series of lithic ash-flow tuffs underlies the tuff of Garcia Camp and is probably related to the older rhyolite dome–flow complexes in the area. The lithic- and pumice-bearing tuffs are very light gray to pinkish gray and contain phenocrysts of quartz and sanidine and clasts of white, crystal-poor pumice and reddish-gray rhyolite in a groundmass consisting mostly of glass shards. The pumice- and rhyolite-fragment content varies widely. The unit attains a maximum thickness of 40 m.

SUMMARY

The stratigraphy of the Indian Peaks area is dominated by the high-silica Taylor Creek Rhyolite and several pyroclastic deposits. The Taylor Creek Rhyolite has been divided into four similar but separate phases that have been named Corduroy Canyon, Indian Peaks, Mojonera Canyon, and Pelona Mountain. The division is based on the combination of detailed mapping, petrography, and minor-element chemistry. The pyroclastic deposits in the area were originally lumped together and called the Railroad Canyon Rhyolite by Elston et al. (1970). However, detailed geologic mapping has shown that the Railroad Canyon Rhyolite consists of the regional Bloodgood Canyon Tuff and the Shelley Peak Tuff, as well as the local tuff of Garcia Camp and several lithic tuffs. Therefore, the term Railroad Canyon Rhyolite should be dropped, as is also recommended by Lawrence & Richter (1986).

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