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SARGENT

WRIR 83-4119-E

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MAP SHOWING OUTCROPS OF PRE-QUATERNARY ASH-FLOW TUFFS AND VOLCANICLASTIC ROCKS, BASIN AND RANGE PROVINCE, NEVADA

Compiled by K. A. Sargent and Kurt Roggensack

Prepared in cooperation with
Nevada Bureau of Mines and Geology

WATER-RESOURCES INVESTIGATIONS REPORT
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SARGENT AND ROGGENSACK, PRE-QUATERNARY ASH-FLOW TUFFS AND VOLCANICLASTIC ROCKS, NEVADA
SCALE 1:500,000 WRIR 83-4119-E

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INTRODUCTION

This map report is one of a series of geologic and hydrologic maps covering all or parts of States within the Basin and Range province of the western United States. The map reports contain detailed information on subjects that characterize the geohydrology of the province, including the ground-water hydrology, ground-water quality, surface distribution of selected rock types, tectonic conditions, areal geophysics, Pleistocene lakes and marshes, and mineral and energy resources. This work is a part of the U.S. Geological Survey's program for geologic and hydrologic evaluation of the Basin and Range province to identify prospective regions for further study relative to isolation of high-level nuclear waste (Bedinger, Sargent, and Reed, 1984).

The map, prepared according to the project guidelines of Sargent and Bedinger (1985), shows the known occurrences of pre-Quaternary ash-flow tuffs, as defined by Stewart and Carlson (1978). The identification of the principal tuffs and units of volcaniclastic rocks within outlined and numbered areas in the counties of the study area is from published geologic maps and reports. Thin tuffs of limited distribution were not included. Outcrops of tuffs for which there is no known geologic data are not included in county areas on the map. The Description of Map Units includes the geologic name, geologic age, radiometric age, if available, general lithology and thickness, and the sources of data for the tuffs and volcaniclastic units in each county area. The radiometric ages do not necessarily represent the entire age range of the geologic units. The nomenclature of the geologic units is from published reports and does not necessarily conform to U.S. Geological Survey usage.

DESCRIPTION OF MAP UNITS

[To convert feet (ft) to meters, multiply feet by 0.3048; to convert miles (mi) to kilometers, multiply miles by 1.609]

County-area number county area	Map symbol	Geologic unit	Geologic and radiometric age in millions of years (m.y.)	Lithology and comments	References for county area
			CHURCHILL COUNTY (CH)		
CH-1	Tt2	Welded ash-flow tuff	Miocene	Rhyolitic welded tuff that probably has a maximum thickness of 200 to 300 ft.	Willden and Speed, 1974
CH-2	Tt2	Welded ash-flow tuff	Miocene and Oligocene	Mainly ash-flow tuff and tuff breccia but some intercalated lacustrine sediments and alluvium. Maximum thickness 650 ft.	Speed, 1976
CH-3	Tt2	Unnamed tuffs, Bates Mountain Tuff, Edwards pre-Edwards Creek tuffs	Miocene and Oligocene, 22 to 29 m.y.	At least 10 cooling units of welded tuff and local lacustrine or air-fall ash interbeds. Ranges in total thickness from 100 to as much as 1,600 ft. Ash flows thin from a large central mass to the northwest and south.	Riehle and others, 1972; Willden and Speed, 1974
CH-4	Tt2	Rhyodacite and quartz latite tuffs	Miocene and Oligocene, 24 to 25 m.y.	In the Desatoya Range, thick, densely welded, crystal-poor tuffs predominate. The crest of the Desatoya Range is composed of a sequence of quartz-latite welded tuff, locally more than 2,000 ft thick, overlying a sequence of rhyodacitic tuff more than 2,000 ft thick in places. There is no discernable unconformity between the quartz latite and rhyodacite sequences. The thickest units are located in a volcano-tectonic depression and probably are very close to, if not within, an unnamed caldera within the depression.	Stewart and McKee, 1977; Willden and Speed, 1974

CH-5	Tt2	Rhyolitic to latitic tuff: rhyolite tuff of War Canyon, crystal tuff of Cherry Valley, basal composite rhyolite unit	Miocene and Oligocene, 22 to about 30 m.y.	In central and southern Clan Alpine Mountains, two sequences of Tertiary volcanic rocks are present (Wilden and Speed, 1974, p. 25). The upper sequence is rhyolitic to rhyodacitic welded ash-flow tuff, containing abundant phenocrysts (10 to 25 percent). The lower sequence is mostly densely welded tuff of rhyolitic and latitic composition containing 5 to 15 percent phenocrysts; lithic fragments are rare. Riehle and others (1972) divide the silicic volcanic pile into five units of rhyolitic lavas and ash-flow tuffs. The total thickness is at least 9,800 ft and perhaps as much as 16,400 ft. The three thickest ash-flow units are: the rhyolite tuff of War Canyon, a tabular body of ash-flow tuff about 980 ft thick; the crystal tuff of Cherry Valley having an exposed thickness of about 4,900 ft and 20 to 30 percent phenocrysts; a basal, composite rhyolite unit greater than 980 ft thick and consisting mostly of ash-flow tuff beds. This part of the Clan Alpine Mountains is within an east-trending volcano-tectonic depression. The great thickness of rhyolites and ash-flow tuffs indicates a very close source area, probably an unnamed caldera centered on the central Clan Alpine Mountains.	Riehle and others, 1972; Willden and Speed, 1974
CH-6	Tt2	Rhyolite to rhyodacite welded tuffs, latite welded tuffs and breccias	Probably Oligocene	Rhyolitic to rhyodacitic devitrified welded tuff; total thickness commonly is greater than 2,000 ft and may possibly be as much as 10,000 ft. The underlying latite tuffs and latite breccias have a total thickness of 2,000 to 6,000 ft.	Page, 1965; Willden and Speed, 1974
CH-7	Tt3	Rhyolitic ash-flow tuffs	Miocene	Welded and nonwelded rhyolitic tuffs form the oldest rocks in the Dead Camel Range. Some water-laid material included in the unit.	Willden and Speed, 1974
CH-8	Tt2	Rhyolitic ash-flow tuffs	Miocene	These rocks are mainly rhyolitic water-laid and air-fall tuffs.	Willden and Speed, 1974

CH-9	Trt	Ash-flow tuffs, rhyolitic flows, and shallow intrusives	Miocene	Stewart and Carlson (1978) assign these rocks a Miocene age, equivalent to unit Tt3. Willden and Speed (1974) put them in their undivided rhyolite to rhyodacite unit of similar age.	Stewart and Carlson, 1978; Willden and Speed, 1974
CH-10	Tt2	Rhyolite to rhyodacite tuffs	Miocene	Fairview Peak, the Slate Mountain area, and the hills to the east largely are composed of tuffs, tuff-breccias, and welded tuffs. The abundance of lithic fragments in tuffs near Fairview Peak and the coarseness of the volcanic breccias indicate a nearby source.	Willden and Speed, 1974
			CLARK COUNTY (CL)		
CL-1	Tt3	Tuff of Bridge Spring	Miocene	Welded, rhyolitic, ash-flow tuff. Usually two distinct cooling units. As much as 400 ft thick.	Anderson and others, 1972; Bingler and Bonham, 1973
CL-2	Tt3	Tuff of Bridge Spring	Miocene, 14.5±0.6 and 14.4±0.5 m.y.	Welded, rhyolitic ash-flow tuff, about 800 ft thick.	Anderson, 1971; Anderson and others, 1972
CL-3	Tt3	Siliceous volcanic rocks	Tertiary	Extrusive and hypabyssal intrusive rocks, mostly rhyolitic, very siliceous, and leucocratic. Includes ash-flow tuffs and layers of perlite. Equivalent to the Mount Davis Volcanics and Golden Door Volcanics (of former usage) of Longwell (1963). Golden Door probably equivalent to the tuff of Bridge Spring.	Longwell, 1963; Volborth, 1973
			DOUGLAS, ORMSBY, AND LYON COUNTIES (DOL)		
DOL-1	Tt2	Hartford Hill Rhyolite (of former usage)	Miocene, 22.7 to 22.8 m.y.	Welded to partly welded rhyolitic ash-flow tuff. Along Truckee River, formation is at least 2,000 ft thick; elsewhere less than 1,000 ft thick. Most of the unit contains 10 to 30 percent crystals. The name Hartford Hill now abandoned and replaced by numerous named tuffs (Bingler, 1978a), described in county area DOL-2.	Bingler, 1978a; Rose, 1969

DOL-2	Tt2	Santiago Canyon Tuff, two unnamed tuffs, Eureka Canyon Tuff, Nine Hill Tuff, Lenihan Canyon Tuff, Mickey Pass Tuff	Miocene and Oligocene	Santiago Canyon Tuff (20.5 and 21.8 m.y.), quartz latite ash-flow tuff, moderately to strongly welded, about 1,000 ft thick; locally underlain by as much as 560 ft of tuff breccia. Unnamed, nonwelded rhyolite tuff as much as 130 ft thick. Unnamed, moderately welded dacite tuff as much as 35 ft thick thick. Eureka Canyon Tuff, weakly welded rhyolite tuff as much as 425 ft thick. Nine Hill Tuff, unwelded to densely welded rhyolite tuff as much as 1,000 ft thick. Lenihan Canyon Tuff (26.7±0.8 and 25.1±0.8 m.y.), moderately to densely welded quartz latite tuff as much as 1,000 ft thick. Mickey Pass Tuff (28.0±0.8 and 28.6±0.9 m.y.), moderately to strongly welded quartz latite tuff as much as 660 ft thick. Volcanic sequence formerly called Hartford Hill Rhyolite.	Bingler, 1977; Moore, 1969
DOL-3	Tt2	Hartford Hill Rhyolite (of former usage), Singatse Tuff, Mickey Pass Tuff	Miocene and Oligocene, 24 to 28 m.y.	Near Yerington, the Hartford Hill Rhyolite (of former usage) is about 4,000 ft thick and composed of rhyolitic tuffs and breccias, and interbeds of volcanic grits. Crystals commonly compose 50 percent of the rock. Much of the rock is nearly structureless, except for crude partings and columnar jointing. Later work by Proffett and Proffett (1976) and Hudson and Oriel (1979) subdivided their Hartford Hill Rhyolite into various tuffaceous and rhyolitic units. The two thickest ash-flow tuffs are the Singatse Tuff, 2,500 ft, and the Mickey Pass Tuff, 1,500 to 2,000 ft. Both are variably welded and are cut by numerous thrust faults in the area.	Hudson and Oriel, 1979; Moore, 1969; Proffett and Proffett, 1976

ELKO COUNTY (EL)

EL-1	Tt1	Indian Well Formation, ash-flow tuff member	Oligocene	The upper middle member of the Indian Well Formation is rhyolitic to dacitic ash-flow tuff that varies from nonwelded to densely welded. Unit is as much as 2,000 ft thick as measured from cross section.	Smith and Ketner, 1978

EL-2	Tt2	Tuffs	Miocene and Oligocene	Tt2 is undescribed.	Evans and Ketner, 1971; Ketner, 1974
	Tt1	Flows and tuffs	Oligocene and Eocene, 37 to 41 m.y.	Evans and Ketner (1971) report that their volcanic-rocks unit chiefly is latite overlain by vitric tuff of late Miocene and early Pliocene age. Their quartz-porphyry unit, mostly stocks, sills, dikes, and flows, contains ash-flow tuff.	
EL-3	Tt1	Indian Well Formation	Oligocene	Rhyolitic to dacitic ash-flow tuff and flow breccias interbedded with volcani-clastic sedimentary rocks. Maximum thickness is 2,100 ft.	Solomon and Moore, 1982a, 1982b; Solomon and others, 1979
EL-4	Tt3, Tt2, and Tt1	Volcanic sequence	Tertiary	Coash (1967) divided the sequence into an upper unit dominantly of porphyritic rhyolite lava and a single welded-tuff flow, and a lower unit of rhyolitic tuff considerably altered to clay. Sequence was divided into three tuff units by Stewart and Carlson (1978). Coash (1967) reports an estimated maximum thickness of about 3,500 ft for the volcanic sequence.	Coash, 1967; Stewart and Carlson, 1978
EL-5	Tt1	Dacitic lithic tuff	Tertiary	Not described.	Hope, 1972

ESMERALDA COUNTY (ES)

ES-1	Tt2	Welded ash-flow tuff	Miocene	Probably rhyolitic to quartz latitic, welded ash-flow tuff. In Royston Hills (southeast of the Cedar Mountains) thickness as much as 3,000 ft, and rocks are steeply dipping. Dips are no greater than 10° in Cedar Mountains.	Albers and Stewart, 1972
ES-2	Tt2	Tuff of Castle Peak	Miocene and Oligocene	Monte Cristo caldera area probably is source of tuff of Castle Peak, which is 240 to 3,000 ft thick, and contains blocks of an older welded tuff. Moore (1981) divides tuff of Castle Peak into three informal units, of which the upper two are welded and the lower one nonwelded.	Moore, 1981; J. H. Stewart, U.S. Geological Survey, written commun., 1982

ES-3	Tt2	Belleville Tuff, Tuff of Eastside Mine, Metallic City Tuff, Tuff of Pinchot Creek, Tuff of Miller Mountain, Tuff of Columbus	Miocene and Oligocene	Part of Candelaria Hills sequence of rhyolitic to quartz-latitic tuff and tuffaceous sediments, includes: Belleville Tuff, densely welded tuff. Tuff of Eastside Mine, weakly to moderately welded, lithic-rich tuff. Metallic City Tuff, moderately to densely welded, crystal-rich ash-flow tuff. Tuff of Pinchot Creek, weakly welded tuff. Tuff of Miller Mountain, welded tuff. Tuff of Columbus, densely welded tuff. Total thickness of sequence 350 ft.	Albers and Stewart, 1972; Ferguson and others, 1954; Robinson and Stewart, 1984; Speed and Cogbill, 1979
ES-4	Tt3	Latite tuff, rhyolite tuffs, and tuffaceous sandstone	Pliocene and Miocene, 6.1 m.y.	Latite tuff as much as 600 ft thick (determined from cross sections), is moderately to densely welded. Rhyolite tuffs mostly are nonwelded flows interbedded with tuffaceous sedimentary rocks, as much as 800 ft thick (from cross section).	Albers and Stewart, 1972; Robinson and Crowder, 1973
ES-5	Tt2	Tuff of Eastside Mine, Metallic City Tuff, Tuff of Volcanic Hills, Tuff of Pinchot Creek, Tuff of Columbus	Miocene and Oligocene	Part of Candelaria Hills sequence of rhyolitic to quartz-latitic tuff and tuffaceous sediments, includes: Tuff of Eastside Mine, unwelded tuff. Metallic City Tuff, moderately to densely welded ash-flow tuff. Tuff of Volcanic Hills, slightly altered unwelded to weakly welded tuff. Tuff of Pinchot Creek, crystal-poor, unwelded ash-flow tuff. Tuff of Columbus, weakly welded crystallized tuff. Total thickness of sequence 550 ft in western part of area; may be as much as 800 ft thick in eastern part of area (cross section by Robinson and others, 1976).	Robinson and Crowder, 1973; Robinson and others, 1976; Robinson and Stewart, 1984
ES-6	Tt3	Rhyolite tuff	Pliocene and Miocene, about 6.0 m.y.	Rhyolite tuff, as much as 1,000 ft thick north of the Silver Peak caldera, 1,500 ft thick east of caldera; intra-caldera tuff as much as 2,000 ft thick (based on topographic contours and geologic cross-sections). Rocks generally are zeolitized.	Robinson and others, 1976; Robinson and Stewart, 1984; Stewart and others, 1974
	Tt2	Candelaria Junction Tuff, Metallic City Tuff	Miocene and Oligocene	Part of Candelaria Hills sequence of rhyolitic to quartz latitic tuff and tuffaceous sediments, includes: Candelaria Junction Tuff (23.6 m.y. average), two cooling units of weakly welded, partly altered, rhyolitic ash-flow tuff; maximum thickness 355 ft. Metallic City Tuff, moderately to densely welded, rhyolitic ash-flow tuff.	

ES-7	Tt3	Rhyolitic air-fall tuff	Pliocene and Miocene, 6.0 m.y.	Mainly rhyolitic air-fall tuff but includes some rhyolitic lava flows and possibly some nonwelded ash-flow tuff.	Albers and Stewart, 1972; Robinson and others, 1968
ES-8	Tt3, and Tt2	Air-fall tuff and tuff breccia	Miocene	Both Tt3 and Tt2 are air-fall tuff and tuff breccia of rhyolitic composition; more than 1,000 ft thick adjacent to Clayton Valley.	Albers and Stewart, 1972
ES-9	Tt2	Fraction Tuff	Miocene	Fraction Tuff contains two members, King Tonopah Member (18.7 m.y.), moderately to densely welded, rhyolite ash-flow tuff, about 660 ft thick; and the underlying Tonopah Summit Member (20 m.y. average), nonwelded to slightly welded quartz latitic to rhyolitic ash-flow tuff, 1,310 ft thick. Both members are hydrothermally altered. Fraction Tuff originally called Fraction Breccia.	Albers and Stewart, 1972; Bonham and Garside, 1979
ES-10	Tt3	Thirsty Canyon Tuff	Miocene, 7.5 m.y.	Thirsty Canyon Tuff, Spearhead Member, is about 80 ft thick near Goldfield. To the south, it thickens to several hundred feet.	Albers and Stewart, 1972; Ashley, 1974; Noble and others, 1964; Ransome, 1909
	Tt2	Sandstorm Formation welded ash-flow tuffs, Kendall Tuff, unnamed latite of Ransome (1909). Vindicator Rhyolite	Miocene or Oligocene	Sandstorm Formation (formerly Sandstorm Rhyolite) contains some welded rhyolitic ash flows. Welded ash flows include the Meda Rhyolite, a biotite-bearing welded tuff, which is 21.1 m.y. old. The Kendall Tuff is an altered, welded ash-flow tuff. The unnamed latite of Ransome (1909) consists of quartz latite tuff and a quartz latite flow. Vindicator Rhyolite is argillized and silicified, rhyolitic, welded tuff. In the Cactus Range to the east a possibly correlative tuff is 25.6 m.y. old.	
ES-11	Tt3	Thirsty Canyon Tuff, Spearhead Member; Timber Mountain Tuff, Ammonia Tanks Member	Miocene, Thirsty Canyon Tuff, 7.5 m.y. Timber Mountain Tuff, 10.5 to 11.5 m.y.	Thirsty Canyon Tuff, probably less than 100 ft thick, caps the Timber Mountain Tuff at eastern end of Slate Ridge. Ammonia Tanks Member of Timber Mountain Tuff, is air-fall, nonwelded to welded tuff, as much as 1,350 ft thick south of Nevada Highway 71 (Albers and Stewart, 1972).	Albers and Stewart, 1972; Byers, Carr, Orkild, and others, 1976

			EUREKA COUNTY (EU)		
EU-1	Tt1	Indian Well Formation, ash-flow tuff member	Oligocene	The upper middle, ash-flow tuff member of Indian Well Formation is rhyolitic to dacitic, nonwelded, and about 600 ft thick, as measured from cross section of Smith and Ketner (1978).	Regnier, 1960; Roberts and others, 1967; Smith and Ketner, 1978
EU-2	Jv	Sod House Tuff	Upper(?) Jurassic	Mostly altered, silicic, ash-flow tuff about 1,000 ft thick.	Smith and Ketner, 1978
EU-3	Tt2	Volcanic rocks	Miocene and Oligocene, 17 to 34 m.y.	As much as 700 ft of rhyolitic tuff and breccia.	Merriam and Anderson, 1942
EU-4	Tt2	Upper tuffs, middle tuffs, and tuff of Summit Mountain	Miocene and Oligocene(?)	Densely to moderately welded ash-flow tuffs. Based on topographic contours, upper tuffs are 100 to 200 ft thick; middle tuffs 400 to 600 ft thick; and tuff of Summit Mountain may be more than 3,500 ft thick.	Anderson and others, 1967
			HUMBOLDT COUNTY (H)		
H-1	Tt3	Idaho Canyon Tuff	Miocene, 15.5 m.y.	Densely welded, devitrified ash-flow tuff.	Cathrall and others, 1978; Noble and others, 1970
H-2	Tt3	Soldier Meadow Tuff	Miocene, 14.7±0.5 m.y.	In the northern part, the Soldier Meadow Tuff is 100 to 200 ft thick (Cathrall and others, 1978). At the type section of Soldier Meadow Tuff in northern Calico Mountains, the tuff is 390 ft of peralkaline rhyolite in multiple ash-flows showing numerous partial cooling breaks. Tuff issued from linear vents near headwaters of Mud Meadow Creek (Korringa, 1973).	Cathrall and others, 1978; Greene and Plouff, 1981; Korringa, 1973; Noble and others, 1970
H-3	Tt3	Tuff of Trough Mountain, Summit Lake Tuff	Miocene	Nonwelded to densely welded ash-flow tuff as much as 1,000 ft thick on Trough Mountain (west of Summit Lake), but thins to less than 150 ft in all directions from Trough Mountain. Contains welded air-fall tuff in middle of unit southwestward of Summit Lake. Summit Lake Tuff, which is 15.5 m.y. old, underlies tuff of Trough Mountain in vicinity of Summit Lake. The Summit Lake is densely welded tuff that rarely exceeds 100 ft in thickness.	Greene and Plouff, 1981; Korringa, 1973; Noble and others, 1970

H-4	Tt3	Tuff of Big Mountain, Summit Lake Tuff, and Idaho Canyon Tuff	Miocene, 15.1 to 15.5 m.y.	The tuff of Big Mountain is partly welded, nearly 300 ft thick where it caps the eastern edge of Big Mountain, and thins to north, south, and west. The type locality for the Summit Lake Tuff is northeast of Summit Lake in the northwestern part of the Black Rock Range. The tuff is subalkaline and widespread but seldom exceeds 100 ft in thickness. The Idaho Canyon Tuff is densely welded and has a maximum thickness of about 400 ft in Idaho Canyon at Big Mountain. Its composition is peralkaline.	Cathrall and others, 1978; Noble and others, 1970; Smith, 1973
H-5	Tt2	Ashdown Tuff	Early Miocene, 23.7±0.7 m.y.	The Ashdown Tuff is densely welded and generally devitrified, and has a maximum measured thickness of about 200 ft. It is present in the Black Rock Range, the northern Calico Mountains, at Big Mountain, in low hills adjacent to the Black Rock Desert, and in intervening areas.	Noble and others, 1970; Smith, 1973
H-6	Tt3	Ash-flow tuff	Early Miocene and late Oligocene(?)	Three ash-flow tuff units, each less than 100 ft thick. The oldest tuff is included in the Pike Creek Formation of southeastern Oregon and is only 15 to 20 ft thick to the north in Oregon (Harrold, 1973). Rytuba and McKee (1984) show that the tuff of Oregon Canyon and the tuff of Trout Creek Mountains are present in this area but correlation with tuffs mapped by Harold (1973) unknown.	Harrold, 1973; Rytuba and McKee, 1984
H-7	Tt3	Tuff of Long Ridge, member 5; tuff of Double H; tuff of Trout Creek Mountains; tuff of Oregon Canyon	Miocene	Tuffs of McDermitt volcanic field: Tuff of Long Ridge, member 5 (15.6 m.y.), nonporphyritic to porphyritic; rhyolite ash-flow tuff; maximum outflow facies thickness as much as 490 ft. Tuff of Double H (15.7 m.y.), densely welded, nonporphyritic, rhyolite ash-flow tuff. Tuff of Trout Creek Mountains (15.8 m.y.), rhyolite ash-flow tuff, less than 100 ft thick. Tuff of Oregon Canyon (15.1 m.y.), nonwelded to densely welded, rhyolite ash-flow tuff, may be as much as 200 ft thick.	Rytuba, Glanzman, and Conrad, 1979; Rytuba and McKee, 1984
	Tt2			Tuffs in small area of Tt2 not described.	

H-8	Tt3	Tuff of Long Ridge, members 5, 3, and 2: tuff of Double H; tuff of Trout Creek Mountains; tuff of Oregon Canyon	Miocene	Tuffs of McDermitt volcanic field: Tuff of Long Ridge, member 5 (15.6 m.y.), non-porphyritic to porphyritic, rhyolite ash-flow tuff, lower part densely welded; intracaldera thickness more than 985 ft, outflow facies as much as 490 ft thick. Tuff of Long Ridge, members 3 and 2 (15.6 m.y.), nonporphyritic to porphyritic, densely welded, rhyolite ash-flow tuff, maximum thickness 754 ft. Tuff of Double H (15.7 m.y.) densely welded, nonporphyritic, rhyolite ash-flow tuff; intracaldera thickness more than 985 ft. Tuff of Trout Creek Mountains (15.8 m.y.), rhyolite ash-flow tuff, thickness less than 100 ft in Nevada. Tuff of Oregon Canyon (16.1 m.y.), non-welded to densely welded, rhyolite ash-flow tuff, as much as 330 ft thick. Rytuba and McKee (1984) discuss the correlation of their tuffs with those mapped by previous workers.	Greene, 1972; Rytuba and Glanzman, 1978; Rytuba and McKee, 1984
H-9	Tt3	Tuff of Hoppin Peaks; tuff of Long Ridge members 5, 3, and 2; tuff of Double H; tuff of Trout Creek Mountains: tuff of Oregon Canyon	Miocene	Tuffs of McDermitt volcanic field: Tuff of Hoppin Peaks (15.5 m.y.), rhyolite ash-flow tuff; intracaldera facies lithic-rich, densely welded, greater than 1,150 ft thick. Tuff of Long Ridge, member 5 (15.6 m.y.), nonporphyritic to porphyritic, rhyolite ash-flow tuff, lower part densely welded; maximum outflow facies 490 ft thick. Tuff of Long Ridge, members 3 and 2, see description in county area H-8. Tuff of Double H (15.7 m.y.), densely welded, nonporphyritic, rhyolite ash-flow tuff, thickness as much as 720 ft. Tuff of Trout Creek Mountains and tuff of Oregon Canyon, see description in county area H-8.	Greene, 1972; Rytuba and Glanzman, 1978; Rytuba, Glanzman, and Conrad 1979; Rytuba and McKee, 1984
H-10	Tt3	Welded quartz latite tuffs	Miocene, 15.3±0.8 m.y.	Welded, quartz latite tuffs, several thousand feet thick.	Ferguson and others, 1951; Gilluly, 1967
H-11	Tt3	Unnamed tuff	Tertiary	The exposed section is about 1,200 ft thick.	Willden, 1963

LANDER COUNTY (LA)					
LA-1	Tt2	Caetano Tuff	Oligocene, 33.6 m.y.	Quartz-latite ash-flow tuff consisting of at least two ash-flows separated by complete cooling break. Age date is from larger eastern outcrop. No more than 200 ft exposed.	Roberts, 1964; Stewart and McKee, 1977
LA-2	Tt2	Bates Mountain Tuff, Caetano Tuff	Oligocene. Caetano Tuff, 33.0 m.y. (average of 11 dates)	The Bates Mountain Tuff occurs as 2 or 3 cooling units each 50 to 150 ft thick. According to present U.S. Geological Survey usage, Bates Mountain Tuff is latest Oligocene age, 25 m.y. The Caetano Tuff is quartz latitic and consists of at least 2 ash-flows. It ranges in total thickness from less than 500 ft to more than 8,000 ft in the northern Toiyabe Range west of Cortez. Much of the tuff, especially in the Shoshone Range south of Horse Mountain, is argillically altered.	Burke and McKee, 1979; Gilluly and Gates, 1965; Gilluly and Masursky, 1965; Masursky, 1960; Stewart and McKee, 1977
LA-3	Tt2	Fish Creek Mountains Tuff	Miocene, 24.3±0.7 m.y.	The Fish Creek Mountains Tuff consists of at least two ash flows separated by a complete cooling break, and of many other ash flows separated by only partial cooling breaks. The welded tuff has vertical columnar joints that cut across all units and horizontal joints. The tuff is 3,000 ft thick or more within the Fish Creek Mountains caldera in south-central Fish Creek Mountains and thins to about 100 ft along the flanks of the range.	McKee, 1970; Stewart and McKee, 1977
LA-4	Tt2	New Pass Tuff, Bates Mountain Tuff, Edwards Creek Tuff	Miocene and Oligocene	New Pass Tuff is a crystal-rich, rhyolitic ash-flow tuff as much as 400 ft thick at the south end of the New Pass Range, and only 100 ft thick east of New Pass. The Bates Mountain Tuff consists of 2 or 3 cooling units, each typically 50 to 150 ft thick, having a partly to non-welded base and top and a welded center. Edwards Creek Tuff composed of as many as 5 cooling units, having total maximum thickness of about 300 ft in eastern Antelope Valley. In most places, the tuff is about 200 ft thick and contains fewer cooling units.	Stewart and McKee, 1977

LA-5	Tt2	Bates Mountain Tuff, Caetano Tuff, unnamed tuffs, tuff of Hall Creek	Oligocene	The Bates Mountain Tuff, widespread in central Lander County, generally consists of 2 or 3 cooling units of crystal-poor rhyolite, each 50 to 150 ft thick that have partly to non-welded bases and tops and densely welded centers. The Caetano Tuff is less than 500 ft thick. Some unnamed ash-flow tuffs, apparently less than a few hundred feet thick occur between the Caetano and the underlying tuff of Hall Creek. The tuff of Hall Creek is massive ash-flow tuff and tuff breccia generally 1,000 ft thick but about 2,000 ft thick and poorly welded north of Mount Callaghan. Its source may have been in the Toiyabe Range.	McKee, 1968a, 1968b, 1976a; Stewart and McKee, 1968, 1977
LA-6	Tt2	Toiyabe Quartz Latite and undivided volcanic and intrusive rocks	Miocene and Oligocene	The Toiyabe Quartz Latite, in vicinity of North Shoshone Peak, is densely welded, crystal-rich, ash-flow tuff of rhyolitic composition, more than 1,000 ft thick. North of the peak, undivided rhyolite lava flows, local ash-flow tuffs, flow breccias, and intrusive rocks comprise the map unit.	Stewart and McKee, 1977

LINCOLN COUNTY (LI)

LI-1	Tt2	Shingle Pass Tuff, Needles Range Formation, and Windous Butte Formation	Oligocene, 25 to 33 m.y.	All units are moderately to densely welded ash-flow tuff; the Shingle Pass Tuff is 125 ft thick; Needles Range, 464 ft; and Windous Butte, 522 ft. Total Tt2 unit thickness exceeds 1,111 ft. Thicknesses from Cook (1965, Shingle Spring section).	Cook, 1965; Ekren and others, 1977
LI-2	Tt2	Needles Range Formation, Windous Butte Formation	Oligocene, 28 to 33 m.y.	Moderately to densely welded ash-flow tuff: Needles Range, more than 1,330 ft thick. Windous Butte, about 278 ft thick. Total Tt2 thickness is as much as 1,608 ft. Thicknesses from Cook (1965, Ely Range section).	Cook, 1965; Ekren and others, 1977
LI-3	Tt2	Needles Range Formation	Oligocene	Ash-flow tuff more than 1,330 ft thick. Thickness from Cook (1965, Fortification Range section).	Cook, 1965; Ekren and others, 1977; Marvin and others, 1973
LI-4	Tt2	Needles Range and Windous Butte Formations	Oligocene, 28 to 33 m.y.	Ash-flow tuff: Needles Range, more than 596 ft thick; Windous Butte, about 100 ft thick. Thicknesses from Cook (1965, Snake Range South section).	Cook, 1965; Ekren and others, 1977

LI-5	Tt2	Condor Canyon Formation, Leach Canyon Formation, Needles Range Formation	Miocene and Oligocene, 21 to 30 m.y.	Ash-flow tuff: Condor Canyon, as much as 449 ft thick; Leach Canyon, as much as 1,000 ft thick. Needles Range, more than 400 ft thick. Total thickness of Tt2 unit 400 to 1,204 ft in Wilson Creek Range (Cook, 1965). Most thicknesses from Cook (1965, Atlanta, Rosencrans Mountain, and Wilson Creek sections).	Cook, 1965; Ekren and others, 1977
LI-6	Tt2	Shingle Pass Tuff, Needles Range Formation, and Windous Butte Formation	Oligocene	Ash-flow tuff: Shingle Pass Tuff, about 122 ft thick; Needles Range, about 1,372 ft thick; and Windous Butte, about 270 ft thick. Thicknesses from Cook (1965, Egan Range South section).	Cook, 1965; Ekren and others, 1977; Marvin and others, 1973
LI-7	Tt2	Leach Canyon Formation, Shingle Pass Tuff, and Needles Range Formation	Miocene and Oligocene, 21 to 30 m.y.	Ash-flow tuff: Leach Canyon Formation, 20 ft thick; Shingle Pass, about 50 ft thick, and Needles Range, about 800 ft thick. Thicknesses from Cook (1965, Fairview Peak and Pony Springs sections).	Cook, 1965; Ekren and others, 1977
LI-8	Tt2	Harmony Hills Tuff, Condor Canyon Formation, Leach Canyon Formation	Miocene	Ash-flow tuff: Harmony Hills Tuff, at least 88 ft thick; Condor Canyon, 630 ft thick; and Leach Canyon, about 800 ft thick. Thicknesses from Cook (1965, Tower Spring section).	Cook, 1965; Ekren and others, 1977
LI-9	Tt2	Needles Range Formation	Oligocene	Ash-flow tuff greater than 300 ft thick; thickness from Cook (1965, Stateline and White Rock Peak sections).	Cook, 1965; Ekren and others, 1977
LI-10	Tt2	Hiko Tuff, Harmony Hills Tuff, Condor Canyon Formation, Leach Canyon Formation, and Needles Range Formation	Miocene and Oligocene, 17.9 to 29.1 m.y.	Ash-flow tuff: Hiko Tuff (17.9 m.y.) 118 to as much as 1,255 ft thick; Harmony Hills Tuff, 100 to 182 ft thick; Condor Canyon Formation (23.5 m.y.) 376 to 460 ft thick; Leach Canyon Formation, 250 to 508 ft thick; Needles Range Formation (29.1 m.y.), about 500 ft thick. Total Tt2 unit thickness is as much as 1,900 ft. Thicknesses from Cook (1965, Condor Canyon, Panaca East and Ursine sections).	Cook, 1965; Ekren and others, 1977
LI-11	Tt2	Needles Range Formation	Oligocene, 28 to 30 m.y.	Ash-flow tuff is 530 to 700 ft thick. Thicknesses from Cook (1965, Ely Springs and Pahrock Range North sections).	Cook, 1965; Ekren and others, 1977; Marvin and others, 1973

LI-12	Tt3	Kane Wash(?) Tuff	Miocene	Ash-flow tuff, probably Kane Wash Tuff.	Cook, 1965; Ekren and others, 1977
	Tt2	Hiko Tuff, Harmony Hills Tuff, Condor Canyon Formation, and Leach Canyon Formation	Miocene, 17.9 to 24 m.y.	Ash-flow tuff: Hiko Tuff, more than 163 ft thick; Harmony Hills Tuff, 177 ft thick; Condor Canyon Formation, 480 ft thick; and Leach Canyon Formation, 778 ft thick. Total Tt2 unit thickness about 1,600 ft. Thicknesses from Cook (1965, Black Canyon section).	
LI-13	Tt2	Hiko Tuff, Harmony Hills Tuff, Condor Canyon Formation, Leach Canyon Formation, and Shingle Pass Tuff	Miocene and Oligocene, 17.9 to 25 m.y.	Ash-flow tuff: Hiko Tuff, as much as 60 ft thick; Harmony Hills Tuff, as much as 263 ft thick; Condor Canyon Formation, 54 to 291 ft thick; Leach Canyon Formation, 315 to 450 ft thick; Shingle Pass Tuff less than 75 ft thick. Thicknesses from Cook (1965, Pahrock Range, Pahrock Range West, Pahrock Spring, Seaman Range South, and White River Narrows sections).	Cook, 1965; Ekren and others, 1977; Marvin and others, 1973
LI-14	Tt2	Leach Canyon Formation, Shingle Pass Tuff	Miocene and Oligocene	Ash-flow tuff: Leach Canyon Formation about 637 ft thick; Shingle Pass Tuff about 430 ft thick. Thicknesses from Cook (1965, Garden Valley section).	Cook, 1965; Ekren and others, 1977
LI-15	Tt3	Kane Wash(?) Tuff	Miocene	Ash-flow tuff, probably correlative with Kane Wash Tuff.	Cook, 1965; Ekren and others, 1977; Marvin and others, 1973
	Tt2	Harmony Hills Tuff, Shingle Pass Tuff, tuff of Bald Mountain, Monotony Tuff	Miocene and Oligocene, 20 to 27.5 m.y.	Ash-flow tuff: Harmony Hills Tuff, about 140 ft thick; Shingle Pass Tuff, about 450 ft thick; tuff of Bald Mountain, about 25 m.y. old, is very densely welded and averages less than 100 ft thick. Monotony Tuff thickness unknown. Thicknesses from Cook (1965, Tempiute Range section) and Ekren and others (1977).	
LI-16	Tt2	Hiko Tuff, Leach Canyon Formation, Shingle Pass Tuff	Miocene and Oligocene	Ash-flow tuff: Hiko Tuff, 300 ft thick; Leach Canyon, more than 300 ft thick; and Shingle Pass, 131 ft thick. Thicknesses from Cook (1965, Hiko West section).	Cook, 1965; Ekren and others, 1977
LI-17	Tt3	Kane Wash Tuff	Miocene, 14.1 to 15.6 m.y.	Contains 5 unnamed members of nonwelded to densely welded rhyolitic to trachytic ash-flow tuff; thickness as much as 1,650 ft. Upper 3 members (14.1 m.y. average) erupted from Kane Springs Wash caldera; lower two members (14.7 and 15.6 m.y. respectively) from source area southwest of caldera.	Cook, 1965; Ekren and others, 1977; Marvin and others, 1973; Noble and McKee, 1972; Novak, 1984

	Tt2	Hiko Tuff, Harmony Hills Tuff, Condor Canyon Formation, and Leach Canyon Formation	Miocene, 17.9 to 24 m.y.	Hiko Tuff, 213 to 1,135 ft thick; Harmony Hills Tuff, as much as 228 ft thick; Condor Canyon Formation, as much as 838 ft thick; and Leach Canyon Formation 108 to 607 ft thick. Thicknesses from Cook (1965, Delamar Range, Hiko Perlite, Hiko Range, Kane Springs Wash, Meadow Valley Range, and Pahranagat Valley South sections).	
LI-18	Tt3	Kane Wash(?) Tuff	Miocene	Ash-flow tuff, probably Kane Wash Tuff.	Cook, 1965; Ekren and others, 1977
	Tt2	Leach Canyon Formation	Miocene	Ash-flow tuff more than 300 ft thick. Thickness from Cook (1965, Caliente North section).	
LI-19	Tt3	Kane Wash Tuff, and Ox Valley Tuff	Miocene	Ash-flow tuff: Kane Wash Tuff is as much as 660 ft thick (Cook, 1965, Rainbow Canyon section section). Ox Valley Tuff (15.1 m.y.) is as much as 500 ft thick in eastern Clover Mountains.	Cook, 1965; Ekren and others, 1977; Marvin and other, 1973; Noble and McKee, 1972
	Tt2	Hiko Tuff, Racer Canyon Tuff, Harmony Hills Tuff, and Condor Canyon Formation	Miocene	Ash-flow tuff: Hiko Tuff contains 2 ash-flow-tuff cooling units with a combined thickness of at least 1,500 ft within the Caliente caldron complex. The Racer Canyon Tuff recognized with certainty only in north-central part of area, where it occurs in 2 cooling units, each more than 100 ft thick, and containing numerous small lithic fragments of welded tuff and intermediate lava (Ekren and others, 1977) The Harmony Hills Tuff is as much as 470 ft thick (Cook, 1965, Delamar section). The Condor Canyon Formation is about 186 ft thick (Cook, 1965, Delamar section).	

MINERAL COUNTY (M)

M-1	Tt2	Hu-Pwi Rhyodacite, Blue Sphinx Tuff, dacite crystal-tuff, vitric tuff, Singatse Tuff, Mickey Pass Tuff	Early Miocene and Oligocene, 22 to 28 m.y.	From youngest to oldest: Hu-Pwi Rhyodacite is more than 1,000 ft thick and consists of crystal-rich, ash-flow tuff. Blue Sphinx Tuff is a thin, non-welded, ash-flow tuff. Dacite crystal-tuff is a simple cooling unit about 300 ft thick, and is discontinuous and limited to area northwest of Black Mountain in the Wassuk Range. Vitric tuff consists of thin, generally nonwelded cooling units. Singatse Tuff is generally moderately welded and thickest, about 2,300 ft, northwest of Black Mountain. Mickey Pass Tuff is a thick sequence of crystal-rich, ash-flow tuffs of rhyodacitic to rhyolitic composition. It is widespread and has a maximum thickness of as much as 1,300 ft in paleogeographic lows in the underlying bedrock.	Bingler, 1978b

M-2	Tt2	Tuff of Redrock Canyon, tuff of Copper Mountain, Hu-Pwi Rhyodacite, Blue Sphinx Tuff, tuff of Gabbs Valley, Petrified Spring Tuff, Singatse Tuff, Mickey Pass Tuff	Miocene and Oligocene, 22 to 28 m.y.	From youngest to oldest: Tuff of Redrock Canyon is a compound cooling unit of partly to densely welded tuff, rhyodacitic at base, quartz latitic at the top. May be as much as 1,000 ft thick and is exposed in the eastern one-third of area. Tuff of Cooper Mountain is moderately to densely welded, except for a nonwelded basal part about 20 ft thick; 250 to 600 ft thick in the north-central part of the area. The Hu-Pwi Rhyodacite is a sequence of rhyodacitic tuffs and lavas as much as 3,300 ft thick, of which more than one-half is densely welded tuff; type locality in the north-western part of the area. The Blue Sphinx Tuff is a multiple-flow, simple cooling unit of quartz latite, and is blue because of moderate hydrothermal alteration. Generally the tuff is 100 to 300 ft thick, but may be 1,000 ft thick in the northern Gillis Range. Tuff of Gabbs Valley is about 260 ft thick. The Petrified Spring Tuff is about 250 ft thick in the southern Gabbs Valley Range. Its occurrence is sporadic due to thrust faulting and the surface of high relief on which it was deposited. The Singatse Tuff is 330 to 1,000 ft thick, moderately to densely welded, and very similar in appearance to outcrops in area DOL-3. The Mickey Pass Tuff consists of two members; the upper member, the Weed Heights Member, is 200 to 400 ft thick but discontinuous in the northern Gillis and Gabbs Valley Ranges. Underlain by the Guild Mine Member, 200 to 1,000 ft thick.	Ekren and Byers, 1978a, 1978b, 1978c, 1978d; Ekren and others, 1980
M-3	Tt2	Belleville Tuff, Metallic City Tuff	Miocene, 22 to 24 m.y.	The Belleville Tuff is welded, rhyodacite, ash-flow tuff, 30 to 200 ft thick. It overlies the Metallic City Tuff which is exposed only as erosional remnants less than 60 ft thick.	Garside, 1979; Robinson and Stewart, 1984
M-4	Tt2	Crystal tuff, rhyodacite tuff, rhyolite tuff	Oligocene	The crystal tuff (27 m.y.) is less than 130 ft thick; the rhyodacite tuff is less than 30 ft thick; the rhyolite tuff may be as much as 500 ft thick, and is present only in the southern outcrop area where its occurrence is more extensive than shown by Stewart and Carlson (1978).	Garside, 1979; Stewart and Carlson, 1978

M-5	Tt3	Ash-flow tuff	Miocene, 9 to 10 m.y.	Trachyandesitic, welded, ash-flow tuff; it is thin in this area but as much as 250 ft thick to the west in California.	Kleinhampl and others, 1975
M-6	Tt3	Ash-flow tuffs, and tuff of Jacks Springs	Miocene, 10 to 11 m.y.	Ash-flow tuffs, described by Kleinhampl and others (1975) in western part of area, are moderately to densely welded, latitic, and as much as 700 ft thick. In the eastern part, correlative ash-flow tuff, called the tuff of Jacks Spring by Stewart (1981a, 1981b), probably is rhyolitic, and has maximum estimated thickness of 250 ft, determined from topographic contours on the geologic map.	Kleinhampl and others, 1975; Robinson and Stewart, 1984; Speed and Cogbill, 1979; Stewart, 1981a, 1981b
	Tt2	Candelaria Junction Tuff, Belleville Tuff, Tuff of Eastside Mine, Metallic City Tuff, Tuff of Volcanic Hills	Miocene and Oligocene	Part of Candelaria Hills sequence of rhyolitic to quartz latitic tuff and tuffaceous sediments, includes: Candelaria Junction Tuff (23.6 m.y. average) moderately welded rhyolitic ash-flow tuff underlain by 165 ft of interbedded tuffs, breccia, and sedimentary rocks. Belleville Tuff, moderately welded ash-flow tuff. Tuff of Eastside Mine, weakly to moderately welded ash-flow tuff. Metallic City Tuff, unwelded to densely welded ash-flow tuff. Tuff of Volcanic Hills, unwelded ash-flow tuff; maximum thickness 130 ft. Entire sequence 550 ft thick.	
M-7	Tt2	Candelaria Junction Tuff, Belleville Tuff, Tuff of Eastside Mine, Metallic City Tuff, Tuff of Candelaria Mountain, Tuff of Volcanic Hills, Tuff of Pinchot Creek, Tuff of Miller Mountain	Miocene and Oligocene	Part of Candelaria Hills sequence of rhyolitic to quartz latitic tuff and tuffaceous sediments, includes: Candelaria Junction Tuff (23.6 m.y. average), nonwelded to densely welded ash-flow tuff. Belleville Tuff, moderately to densely welded tuff; thickness highly variable, maximum 260 ft. Tuff of Eastside Mine, unwelded tuff; maximum thickness 425 ft. Metallic City Tuff, weakly to densely welded ash-flow tuff; maximum thickness 230 ft. Tuff of Candelaria Mountain, unwelded to weakly welded tuff; maximum thickness 260 ft. Tuff of Volcanic Hills, weakly to densely welded tuff. Tuff of Pinchot Creek, unwelded to moderately welded ash-flow tuff; maximum thickness 115 ft. Tuff of Miller Mountain, moderately welded tuff; average thickness 130 ft. Source of the Candelaria Hills sequence probably within the Candelaria Hills.	Robinson and Stewart, 1984; Speed and Cogbill, 1979; Stewart, 1979

NYE COUNTY, NORTHERN HALF (NN)					
NN-1	Tt2	Leach Canyon Formation, Shingle Pass Tuff	Miocene and Oligocene	Ash-flow tuff: Leach Canyon, 267 ft thick; Shingle Pass, 208 ft thick. Thicknesses from Cook (1965, Golden Gate Range section).	Cook, 1965
NN-2	Tt2	Shingle Pass Tuff, Needles Range Formation	Oligocene	Ash-flow tuff: Shingle Pass Tuff, about 160 ft thick; Needles Range, 370 to 1,055 ft thick. Thicknesses from Cook (1965, Egan Range Southwest and Seaman Range North sections).	Cook, 1965
NN-3	Tt2	Shingle Pass Tuff, Needles Range Formation, Windous Butte Formation, Stone Cabin Formation, and Calloway Well Formation	Oligocene	Ash-flow tuff: Shingle Pass Tuff is as much as 1,675 ft thick in southern part of area and thins northward; Needles Range Formation, as much as 1,369 ft thick in southern part of area and thins northward; Windous Butte Formation (30.2 to 30. 7 m.y.) may be as much as 1,665 ft thick; Stone Cabin Formation (32.4 to 34.1 m.y.) may be as much as 2,360 ft thick in northern part and thins southward; Calloway Well Formation (33.2 m.y.), 604 ft thick in north-central part of area. Thicknesses from Cook (1965, Forest Home, North, Albert Spring, Grant Range East, Stone Cabin, and Grant Range West sections), and from Scott (1965, Forest Home, Hubbard, and other measured sections).	Armstrong, 1970; Cook, 1965; Gromme and others, 1972; Scott, 1965
NN-4	Tt2	Shingle Pass Tuff, Monotony(?) Tuff, and Needles Range Formation	Oligocene	Total ash-flow tuff sequence probably is 3,000 to 5,000 ft thick. Quinn Canyon Range probably was an eruptive center, but it is not known just which tuffs came from that center. Ekren and others (1977) believe the range represents a resurged cauldron, based on the presence of thick ash-flow tuffs in the domed central part and rhyolite plugs and lava flows on the flanks.	Ekren and others, 1977; Sainsbury and Kleinhampl, 1969

NN-5	Tt2	Shingle Pass Tuff, Monotony Tuff, tuff of Big Round Valley, tuff of Black Rock Summit, tuff of Williams Ridge and Morey Peak, Windous Butte Formation, tuff of Cottonwood Canyon, tuff of Pritchards Station, Stone Cabin Formation	Oligocene	Ash-flow tuff: Shingle Pass Tuff is as much as 160 ft thick; Monotony Tuff, as much as 800 ft thick; tuff of Big Round Valley, as much as 700 ft thick; tuff of Black Rock Summit, as much as 1,450 ft thick; tuff of Williams Ridge and Morey Peak, as much as 3,900 ft thick; Windous Butte Formation, as much as 100 ft thick; tuff of Cottonwood Canyon, as much as 250 ft thick; and tuff of Pritchards Station, as much as 700 ft thick. The Stone Cabin Formation has 3 cooling units which together are as much as 3,000 ft thick.	Quinlivan and others, 1974
NN-6	Tt2	Bates Mountain Tuff, Shingle Pass Tuff, tuff of Orange Lichen Creek, tuff of Pott Hole Valley, Crested Wheat Ridge, Windous Butte Formation, tuff of Cottonwood Canyon, tuff of Pritchards Station, Stone Cabin Formation	Oligocene	Ash-flow tuff: Bates Mountain Tuff, present U.S. Geological Survey usage recognized Bates Mountain Tuff as latest Oligocene (25 m.y.); as much as 150 ft thick; Shingle Pass Tuff (25.1 m.y.), as much as 190 ft thick; tuff of Orange Lichen Creek, as much as 200 ft thick; tuff of Pott Hole Valley, as much as much as 350 ft thick; tuffs of Crested Wheat Ridge, as much as 800 ft thick; Windous Butte Formation, as much as 1,800 ft thick, tuff of Cottonwood Canyon, as much as 180 ft thick; tuff of Pritchards Station, as much as 480 ft thick; and Stone Cabin Formation, as much as 700 ft thick.	Dixon and others, 1972; Sargent and McKee, 1969

NN-7	Tt2	Tuff of Moores Station Buttes, tuffs between the tuffs of Moores Station Buttes and tuff of The Needles, tuff of The Needles area, tuff of Hot Creek Canyon, tuff of Palisade Mesa, tuff of Halligan Mesa, tuff of Chaos Creek, tuff of Williams Ridge and Morey Peak	Miocene and Oligocene	The thickest ash-flow tuff units in the area are: tuff of Moores Station Buttes 0 to 1,000 ft; a unit 0 to 900 ft thick of tuffs between the tuff of Moores Station Buttes and tuff of The Needles; tuff of The Needles 0 to 1,000 ft, tuff of The Needles area 0 to 1,500 ft; tuff of Hot Creek Canyon 0 to 1,500 ft, tuff of Palisade Mesa 400 ft; tuff of Halligan Mesa 600 ft; tuff of Chaos Creek 0 to 600 ft; and tuff of Williams Ridge and Morey Peak, more than 6,500 ft thick. The area is mostly within the Hot Springs Valley caldera complex, and the aggregate thickness of ash-flow tuffs exceeds 10,000 ft.	Ekren, Hinrichs, and others, 1973
NN-8	Tt2	Granite-weathering tuff, tuff of Buckwheat Rim, tuff of Buckskin Point, tuff of Lunar Cuesta, Shingle Pass Tuff, Monotony Tuff, tuff of Palisade Mesa, tuff of Halligan Mesa, tuff of Black Rock Summit, and tuff of Williams Ridge and Morey Peak	Miocene and Oligocene	Thicknesses of ash-flow tuff in area are: granite-weathering tuff 0 to 200 ft; tuff of Buckwheat Rim 0 to 500 ft; tuff of Buckskin Point 0 to 250 ft; tuff of Lunar Cuesta 0 to 400 ft; Shingle Pass Tuff 0 to 750 ft; Monotony Tuff 0 to 1,500 ft; tuff of Palisade Mesa 0 to 400 ft; tuff of Halligan Mesa 600 ft; tuff of Black Rock Summit 0 to 1,200 ft; tuff of Williams Ridge and Morey Peak 1,000 ft. Tuffs are associated with the Lunar Lake, Pancake Range, and Williams Ridge calderas.	Ekren and others, 1972; Snyder and others, 1972
NN-9	Tt2	Granite-weathering tuff, tuff of Lunar Cuesta, Shingle Pass Tuff, tuff of Kiln Canyon, tuff of Orange Lichen Creek(?), Monotony Tuff, tuff of Hot Creek Canyon, tuff of Twin Peaks, Windous Butte Formation, and tuff of Williams Ridge and Morey Peak	Miocene and Oligocene	Approximate maximum thickness of ash-flow tuff units is: granite-weathering tuff 300 ft; tuff of Lunar Cuesta 300 ft; Shingle Pass Tuff 600 ft; tuff of Kiln Canyon 1,800 ft; tuff of Orange Lichen Creek(?) 1,000 ft; Monotony Tuff 2,500 ft; tuff of Hot Creek Canyon 3,200 ft; tuff of Twin Peaks 3,000 ft; Windous Butte Formation 1,600 ft; tuff of Williams Ridge and Morey Peak 5,000 ft. Anderson and others (1967, cross section A-A') show thickness of tuff section in central Hot Creek Range as much as 7,000 ft. The northern part of the area is within the Hot Creek Valley caldera complex.	Anderson and others, 1967; Ekren, Bath, and others, 1974; Quinlivan and Rogers, 1974

NN-10	Tt2	Tuff of Lunar Cuesta, Bates Mountain Tuff, Shingle Pass Tuff, tuff of Kiln Canyon, tuff of Orange Lichen Creek, tuff of Pott Hole Valley, tuff of Crested Wheat Ridge, tuff of the northern Monitor Range, tuff of the Monitor Range, tuff of Hot Creek Canyon, Windous Butte Formation, tuff of Williams Ridge and Morey Peak	Oligocene	Thickest units are Bates Mountain Tuff (now recognized as of latest Oligocene age), Shingle Pass Tuff, Windous Butte Formation, and tuff of the Monitor Range. Total thickness of tuffs may be as much as 9,000 ft (Anderson and others, 1967, cross section A-A').	Anderson and others, 1967; Ekren, Bath, and others, 1974
NN-11	Tt2	Tuffs of Rye Patch, and tuffs of uncertain correlation	Tertiary, probably Oligocene, 26 to 31 m.y.	Tuffs of Rye Patch may be as much as a few miles thick, and most are hydrothermally altered (phyllitic and potassic alteration). Other tuffs in the area may include units correlative with the tuff of Kawich Range, Monotony Tuff, and Windous Butte Formation. These units fill the Big Ten Peak caldera.	Anderson and others, 1967; Bonham and Garside, 1979
NN-12	Tt2	Heller Tuff, Fraction Tuff, Tonopah Formation, tuffs of Rye Patch, tuff of Ralston Valley, tuff of Antelope Springs(?)	Miocene and Oligocene, 17 to 31	Heller Tuff has a maximum exposed thickness of about 270 ft and overlies the Fraction Tuff. The Fraction Tuff consists of at least 6 rhyolitic ash-flows, the thickest being greater than 980 ft and slightly welded. Estimated total thickness of the Fraction Tuff is 2,000 to 3,000 ft. The Tonopah Formation is as much as 1,000 ft thick and contains rhyolitic welded tuffs. Tuffs of Rye Patch are 270 ft thick near Tonopah, but thicken to more than 3,000 ft to the northeast. Tuff of Ralston Valley is about 500 ft thick. Tuff of Antelope Springs(?) is at least 300 ft thick.	Bonham and Garside, 1979; Silberman and McKee, 1972

NN-13	Tt2	Shingle Pass(?) Tuff, tuffs in Manhattan caldera, tuff of Mount Jefferson, tuff of Hoodoo Canyon, Northumberland Tuff.	Oligocene	Shingle Pass(?) Tuff and stratigraphically adjacent units are down faulted on east side of Mount Jefferson, where they are 1,000 to 1,500 ft thick (F. J. Kleinhampl, and J. I. Ziony, U.S. Geological Survey, written commun., 1983). Tuffs associated with the Manhattan caldera (D.R. Shawe, U.S. Geological Survey, written commun., 1985) are latitic, quartz latitic, and rhyolitic ash-flow and ash-fall tuffs (about 25 m.y.) containing intercalated megabreccia. Upper part contains unit of sedimentary rock as much as 820 ft thick. Total thickness of sequence may exceed 6,580 ft; relationship to other tuffs in county area uncertain. Tuff of Mount Jefferson (26 m.y.), at least 6,560 ft thick in Mount Jefferson caldera. Tuff of Hoodoo Canyon is 30 m.y. old. Northumberland Tuff (32 m.y.) is no more than 100 ft thick.	Anderson and others, 1967; Boden and Harrington, 1984; McKee, 1974
NN-14	Tt2	Tuff of Hoodoo Canyon, tuff of Stoneberger Canyon, Northumberland Tuff	Oligocene	Tuff of Hoodoo Canyon is locally more than 400 ft thick; tuff of Stoneberger Canyon (31.1 m.y.) is about 800 ft of dense, structureless, crystal-rich, lithic-fragment-bearing, tuff breccia. Northumberland Tuff (32.3 ± 1 m.y.) is more than 1,000 ft thick in the Northumberland caldera, but outside the caldera, in the northern part of the area, is less than 100 ft thick.	McKee, 1974, 1976b

NN-15	Tt2	Toiyabe Quartz Latite, tuffs of Peavine Canyon (Kleinhampl and Ziony, 1985), Darrough Felsite, Underdown Tuff, and tuff of Grantsville Canyon	Miocene and Oligocene, 21 to 26.1 m.y.	The Toiyabe Quartz Latite (21 to 24 m.y.) is a widely distributed, densely welded tuff in northern Nye and Lander Counties; thickness probably exceeds 1,500 ft. Tuffs of Peavine Canyon consists of three units of rhyolitic to quartz latitic(?) ash-flow tuff, and crops out mainly in the southeast part of the county area in the Peavine caldera. The tuff unit is more likely older than the Toiyabe Quartz Latite, but its age relation to older units in the area is unknown. Darrough Felsite (22 to 26 m.y. or older) is a compacted, dense, crystal-rich (20 to 60 percent phenocrysts), ash-flow tuff and tuff breccia; occurs only in Darrough caldera where it may exceed 6,560 ft in thickness (Speed and McKee, 1976). Underdown Tuff (26.1 m.y.) is a crystal-poor, densely welded, rhyolitic ash-flow tuff, which crops out on the east side of the Shoshone Mountains north of 39°. Measured thicknesses are as much as 1,600 ft. Tuff of Grantsville Canyon, as shown by Vitaliano and Vitaliano (1972), occurs south of 39° in the Shoshone Mountains. It consists of more than 3,700 ft of mainly rhyolitic tuff breccia; age is uncertain.	Bonham, 1970; Ferguson and Cathcart, 1954; Speed and McKee, 1976; Vitaliano, 1963; Vitaliano and Vitaliano, 1972
NN-16	Tt2	Toiyabe Quartz Latite	Miocene	Is as much as 2,000 ft thick.	Vitaliano, 1963; Vitaliano and Callaghan, 1963; Vitaliano and Vitaliano, 1972
NN-17	Tt2	Tuffs of Gabbs Valley	Miocene, 25 m.y.	Rhyolitic ash-flow tuff; 2 tuffs are about 1,000 ft thick along western margin of inferred caldron.	Ekren and Byers, 1976

NYE COUNTY, SOUTHERN HALF (NS)					
NS-1	Tt3	Thirsty Canyon Tuff	Miocene, 6 to 7 m.y.	Flow generally less than 100 ft thick.	Ekren and others, 1971
	Tt2	Tuff of White Blotch Spring, tuffs of Antelope Springs, Monotony Tuff	Miocene and Oligocene, 22 to 27 m.y.	Tuff of White Blotch Spring (22 to 25 m.y.) estimated to exceed 3,000 ft in thickness, is intensely faulted and hydrothermally altered. The tuffs of Antelope Springs (26 to 27 m.y.) have a composite thickness of about 5,600 ft; however, they are intensely faulted and hydrothermally altered. Monotony Tuff (26 to 27 m.y.) has an average thickness of about 1,000 ft.	
NS-2	Tt2	Intracaldron tuffs of Kawich Peak, and tuff of Kawich caldera	Miocene and Oligocene, 22 to 25 m.y.	Intracaldron tuffs of Kawich Peak are rhyodacitic, welded ash-flow tuffs, which overlie the tuff of Kawich caldera; thickness is variable but maximum is about 1,000 ft. Tuff of Kawich caldera (22 to 25 m.y.) is densely welded to nonwelded, rhyolitic ash-flow tuff at least 3,000 ft thick; includes the tuff of White Blotch Spring of Ekren and others (1971).	Ekren and others, 1971; Gardner and others, 1980
NS-3	Tt2	Tuff of Buckwheat Rim, tuff of Lunar Cuesta, tuff of Streuben Knob, tuff of Reveille Range, tuff of northern Reveille Range, Shingle Pass Tuff, tuff of Arrowhead, Montony Tuff, tuff of Williams Ridge and Morey Peak(?)	Miocene and Oligocene	Maximum thicknesses of ash-flow tuffs are: tuff of Buckwheat Rim 300 ft, tuff of Lunar Cuesta 400 ft, tuff Streuben Knob 400 ft, tuff of Reveille Range 500 ft, tuff of northern Reveille Range 500 ft, Shingle Pass Tuff 820 ft, tuff of Arrowhead 800 ft, Monotony Tuff 6,000 ft, tuff of Williams Ridge and Morey Peak(?) 500 ft.	Ekren, Rogers, and Dixon, 1973

NS-4	Tt2	Tuff of White Blotch Spring	Miocene and Oligocene, 22 to 25 m.y.	Tuff of White Blotch Spring is as much as 2,000 ft thick in southern Reveille Range, where it consists of 3 or more cooling units. In the Kawich Range, 2 cooling units, each about 400 ft thick, are present. White Blotch was called "tuff of the Kawich Range" by Rogers and others (1967).	Ekren and others, 1971; Rogers and others, 1967
NS-5	Tt2	Fraction Tuff, tuff of Kawich Range, Monotony Tuff	Miocene and Oligocene	The Fraction Tuff (17.8 m.y.) is about 7,200 ft thick and densely welded in the Cathedral Ridge caldera. To the south, outside the caldera, it is in part very slightly welded. Tuff of Kawich Range (22 to 25 m.y.) (also known as tuff of White Blotch Spring) is densely welded, as much as 750 ft thick, and crops out north of the caldera. Monotony Tuff is as much as 2,000 ft thick.	Ekren and others, 1971; Rogers and others, 1967
NS-6	Tt3	Belted Range Tuff, Grouse Canyon Member	Miocene	Partly to densely welded ash-flow tuff, 50 ft thick.	Ekren and others, 1967, 1971; Sargent and Orkild, 1973
	Tt2	Fraction Tuff, tuff of White Blotch Spring, Shingle Pass Tuff, Monotony Tuff	Miocene and Oligocene	The Fraction Tuff is as much 1,000 ft thick in the Belted Range and in Monotony Valley to the east. Tuff of White Blotch Spring is 300 to about 900 ft thick. Shingle Pass Tuff is densely welded, devitrified, and 450 to 800 ft thick. Monotony Tuff is about 2,300 ft thick south of Nevada Highway 25, and about 1,000 ft thick in northern Belted Range.	
NS-7	Tt3	Timber Mountain Tuff, Paintbrush Tuff, Stockade Wash Tuff, tuff of Basket Valley, Belted Range Tuff, Crater Flat Tuff, ash-flow tuff of Cache Cave Draw, and Redrock Valley Tuff	Miocene, 11.1 to 15.7 m.y.	Timber Mountain Tuff composed of the Ammmonia Tanks (11.1 m.y.) and Rainier Mesa Members (11.3 m.y.), each probably as much as 150 ft thick in the area. Paintbrush Tuff, Tiva Canyon Member, as much as 125 thick. Stockade Wash Tuff as much as 400 ft thick. Tuff of Basket Valley, as much as 300 ft thick. Belted Range Tuff composed of the Grouse Canyon Member (13.8 m.y.), as much as 360 ft thick, and the Tub Spring Member, as much as 350 ft thick. Crater Flat Tuff (14 m.y.) is as much as 500 ft thick. Ash-flow tuff of Cache Cave Draw is as much as 400 ft thick. Redrock Valley Tuff (15.7 m.y.) has a measured thickness of 1,370 ft in a drill hole about 5 mi north-west of Pinyon Butte.	Byers, Carr, Orkild, and others, 1976; Sargent and Orkild, 1973

	Tt2	Fraction Tuff, tuff of White Blotch Springs, Shingle Pass Tuff, Monotony Tuff	Miocene and Oligocene, 17.5 to 27 m.y.	Fraction Tuff (17.5 m.y.) has a measured thickness of 784 ft in a drill hole about 2 mi north of Pinyon Butte. Tuff of White Blotch Springs is 300 to 800 ft thick. Shingle Pass Tuff (25 m.y.) is 500 to 800 ft thick. Monotony Tuff (26 to 27 m.y.) is 300 to 700 ft thick.	
NS-8	Tt3	Thirsty Canyon Tuff, Timber Mountain Tuff, Paintbrush Tuff, tuff of Dead Horse Flat, Belted Range Tuff	Miocene	Thirsty Canyon Tuff consists of 3 members, from top to bottom, the Trail Ridge, Spearhead, and Rocket Wash Members, each 200 to more than 400 ft thick. Timber Mountain Tuff consists of, the upper Ammonia Tanks Member, 300 ft thick, and the lower Rainier Mesa Member, 1,300 ft thick; both are largely densely welded. Welded tuff members of the Paintbrush Tuff are: Tiva Canyon Member (youngest), 370 ft thick, tuff of Blacktop Buttes, 640 ft thick, and Topopah Spring Member 450 ft thick. On Pahute Mesa, tuff of Dead Horse Flat locally is more than 1,400 ft thick, but deeply buried in the Silent Canyon caldera. Belted Range Tuff (13.8±0.5 m.y.) consists of 2 ash-flow tuff members, each more than 1,700 ft thick and also deeply buried under Pahute Mesa in the Silent Canyon caldera. Thicknesses of volcanic units on Pahute Mesa are known from exploratory holes drilled by the U.S. Department of Energy.	Byers, Carr Orkild, and others, 1976; Noble, Sargent, and others, 1968; Orkild and others, 1968, 1969
NS-9	Tt3	Thirsty Canyon Tuff, Gold Flat, Trail Ridge, and Spearhead Members; Belted Range Tuff, Grouse Canyon Member	Miocene	Thirsty Canyon Tuff: total thickness of its 3 members is less than 250 ft. The Grouse Canyon Member of Belted Range Tuff is less than 100 ft thick.	Ekren and 1971; Rogers and others, 1968
	Tt2	Fraction Tuff, tuff of Wilsons Camp, tuff of White Blotch Spring, tuffs of Antelope Springs	Miocene and Oligocene	Fraction Tuff is several hundred feet thick in the north part of the area. Tuff of Wilsons Camp, exposed in vicinity of Gold Mountain, consists of 2 cooling units, each 50 to 300 ft thick, dominantly poorly welded and vitric and locally intensely zeolitized or silicified. Tuff of White Blotch Spring may be as much as 700 ft thick. Tuffs of Antelope Springs are largely altered.	

NS-10	Tt3	Stonewall Flat Tuff, Thirsty Canyon Tuff, Timber Mountain Tuff, Belted Range Tuff, Grouse Canyon Member, and tuff of Tolicha Peak	Miocene	Stonewall Flat Tuff (6.3 m.y.) named by Noble and others (1984) in Stonewall Mountain area consists of two members: Civet Cat Canyon Member, rhyolitic ash-flow tuff, maximum thickness 1,000 ft; and Spearhead Member, moderately to densely welded, rhyolitic ash-flow tuff. Correlation of units in Stonewall Flat Tuff with units in Thirsty Canyon Tuff discussed by Nobel and others (1984). Thirsty Canyon Tuff, erupted from Black Mountain caldera, is widespread and consists of 5 tuff members of variable welding and thickness. Maximum thickness of the members, in descending order is: Upper member, air-fall(?) tuff, 16 ft; Gold Flat Member ash-flow tuff, 200 ft; Trail Ridge Member, ash-flow tuff, 200 ft; Pahute Mesa Member, ash-flow tuff, formerly Spearhead Member (Noble and others, 1984), 400 ft; and Rocket Wash Member, ash-flow tuff, 285 ft. Timber Mountain Tuff consists of Ammonia Tanks and Rainier Mesa Members, each 200 to 700 ft thick. The Grouse Canyon Member of Belted Range Tuff is as much as 300 ft thick and densely welded. Tuff of Tolicha Peak, probably associated with the Mount Helen caldera, is densely welded compound cooling unit about 300 ft thick about 11 mi northwest of Black Mountain, but to the north, in the southern part of the Mount Helen caldera, the tuff contains 3 cooling units separated from each other by fluvial and lacustrine sedimentary rocks and air-fall tuff. In the latter area the composite thickness of the tuff of Tolicha Peak is more than 1,400 ft.	Byers, Carr, Orkild, and others, 1976; Byers and others, 1968; Christiansen and Noble, 1965, 1968; Ekren and others, 1971; Noble and Christiansen, 1968, 1974; Noble and others, 1964, 1984; Rogers and others, 1968
	Tt2	Tuff of Wilsons Camp, tuffs of Antelope Springs	Miocene and Oligocene	Tuff of Wilson Camp is a simple cooling unit 100 to 200 ft thick north of Black Mountain. Tuffs of Antelope Springs (26 to 27 m.y.) comprise a densely welded, hydrothermally altered, compound cooling unit as much as 1,500 ft thick.	

NS-11	Tt3	Timber Mountain Tuff, Paint-brush Tuff, and Crater Flat Tuff, Bullfrog Member	Miocene	Timber Mountain Tuff composed of the Ammonia Tanks Member at the top, more than 800 ft thick, and at the Rainier Mesa Member at the base, more than 1,000 ft thick in the vicinity of Bullfrog Hills, which apparently was area of a paleotopographic low throughout most of the Miocene. Elsewhere, the members of the Timber Mountain Tuff each have maximum thick-ness of about 500 ft. The Paintbrush Tuff, composed of the Tiva Canyon and Topopah Springs Members, is more than 500 ft thick in the Bullfrog Hills. Bullfrog Member of the Crater Flat Tuff is 430 ft thick in the Bullfrog Hills.	Byers, Carr, Orkild, and others, 1976
NS-12	Tt3	Timber Mountain Tuff, Paint-brush Tuff, and Crater Flat Tuff	Miocene	Ash-flow tuffs are very thick inside the Timber Mountain-Oasis Valley caldera complex which comprises the northern one-half of this area. Units of the Timber Mountain Tuff are: tuff of Buttonhook Wash 800 ft thick, Ammonia Tanks, Member (11.1 m.y.) 2,800 ft thick, Rainier Mesa Member (11.3 m.y.) 1,500 ft thick. Paintbrush Tuff (12.5 to 13.2 m.y.) has 5 members that are locally thick and densely welded, especially in the Claim Canyon caldera; from youngest to oldest: Tuff of Pinyon Pass 500 ft thick; Tiva Canyon Member, 5,000 ft thick; Yucca Mountain Member, 1,000 ft thick; Pah Canyon Member, 700 ft thick; and Topopah Spring Member, 1,000 ft thick. In the southern one-half of the area, outside the Timber Mountain-Oasis Valley caldera complex, aggregate thickness of the Timber Mountain is only about 300 ft, and the Paintbrush Tuff about 1,500 ft. Crater Flat Tuff (13.5 m.y., average) in the Crater Flat-Prospector Pass caldera complex area is composed of 3 ash-flow tuff members, from youngest to oldest, the Prow Pass Member, 0 to 840 ft thick and generally densely welded. The Bullfrog Member, 0 to more than 1,300 ft thick, is nonwelded to densely welded. The basal Tram Member, 0 to at least 1,224 ft thick, generally is partly to moderately welded in the upper one-half and nonwelded to partly welded and lithic in the lower one-half.	Byers, Carr, Christiansen, and others, 1976; Byers, Carr, Orkild, and others, 1976; Carr, 1982; Carr and others, 1984; Lipman and McKay, 1965; McKay and Sargent, 1970; Snyder and Carr, 1982

NS-13	Tt3	Timber Mountain Tuff, Paintbrush Tuff, flows and tuffs of Wahmonie Flat, and Crater Flat Tuff	Miocene	Timber Mountain Tuff; Ammonia Tank Member is as much as 225 ft thick, Rainier Mesa Member 560 ft thick. Paintbrush Tuff; Tiva Canyon Member as much as 360 ft thick, Topopah Spring Member, 900 ft thick. Flows and tuffs of Wahmonie Flat consists of mudflow breccia, lava flows, and tuffs in a sequence as much as 2,600 ft thick. The Crater Flat Tuff is as much as 600 ft thick southwest of Skull Mountain.	Ekren and Sargent, 1965; McKay and Williams, 1964; McKeown and others, 1976; Orkild, 1968; Sargent and Stewart, 1971
NS-14	Tt3	Timber Mountain Tuff, Paintbrush Tuff	Miocene	Timber Mountain Tuff; Ammonia Tanks Member is as much as 480 ft thick, and Rainier Mesa Member, 300 ft thick. Topopah Spring Member of the Paintbrush Tuff is as much as 400 ft thick.	Byers and Barnes, 1967; Hinrichs and McKay, 1965
	Tt2	Monotony(?) Tuff	Oligocene	Monotony(?) Tuff is 200 ft thick.	

PERSHING COUNTY (P)

P-1	Tt3	Welded tuff	Miocene, 12.7 m.y.	Outcrops in the Trinity Range are rhyolitic tuff that locally is densely welded in upper part, and grades downward into nonwelded vitric tuff. The large outcrop at the south end of area centers on the Ragged Top caldera.	Johnson, 1977; Willden and Speed, 1974
P-2	Tt3 and Tt2	Rhyolitic tuff and breccia	Miocene and late Oligocene	Locally welded and nonwelded tuffs occur in the volcanic sequence consisting of plugs, domes, flows, and tuffs. Speed (1976) reports rocks in the Humboldt Range as mainly ash-flow tuff and tuff breccia. Dated rocks (28 m.y.) from West Humbolt Range.	Johnson, 1977; Speed, 1976
P-3	Tt3 and Tt2	Rhyolitic and dacitic volcanic rocks	Tertiary	Several units containing dacitic, welded tuff, crystal-vitric tuff, and glassy tuff. Units appear to be more than 500 ft thick, based on topographic contours and geologic structure.	Wallace and others, 1969
P-4	Tt2	Rhyolitic tuff and breccia		See area P-2 for lithologic description.	Johnson, 1977; Speed, 1976
P-5	Tt2	Caetano Tuff	Oligocene, 33.6±1.1 m.y.	Sheet of rhyolitic ash-flow tuff about 300 ft thick; upper 150 ft densely welded (Johnson, 1977). Burke and McKee (1979), however, believe the Caetano Tuff is 1,500 to 1,800 ft thick in southern Tobin Range.	Burke and McKee, 1979; McKee and others, 1971

P-6	Tt2	Fish Creek Mountains Tuff	Miocene, 24.6±1.3 m.y.	One cooling unit of crystal-rich, rhyolitic ash-flow tuff, almost entirely welded. Thickness not reported, but appears to range from 0 to 150 ft (Johnson, 1977, fig. 10). Unit includes some Bates Mountain Tuff.	Johnson, 1977
P-7	Tt2	Rhyolitic tuff and breccia		See area P-2 for lithologic description.	Johnson, 1977; Speed, 1976

WASHOE AND STOREY COUNTIES (WS)

WS-1	Tt3	High Rock sequence	Pliocene and late Miocene	A sequence of ash-flow tuffs, tuffaceous fluvio-lacustrine deposits, and mafic tuffs, called the High Rock sequence by Bonham (1969), later subdivided by Stewart and Carlson (1978). Lithic fragments are common in the ash-flow tuff, locally constituting as much as one-third of the tuff. The ash-flow tuff is a soda rhyolite, massive, and shows little or no discernable layering or sorting. The High Rock sequence ranges in thickness from 0 to about 1,200 ft. High Rock sequence may be equivalent to Soldier Meadow Tuff in areas to east of WS-1 (Cathrall and others, 1978).	Bonham, 1969; Cathrall and others, 1978; Stewart and Carlson, 1978
WS-2	Tt2	Hartford Hill Rhyolite (of former usage)	Miocene, 22.7 to 22.8 m.y.	Rhyolitic to quartz latitic ash-flow and ash-fall tuff containing minor clastic sedimentary rock. Welding varies from nonwelded to densely welded. Individual tuffs range in thickness from 5 ft to 300 ft. Total thickness of Hartford Hill (of former usage) about 4,000 ft in the Mullen Pass and Dogskin Mountain areas. Unit is extensively altered by hydrothermal solutions. The name Hartford Hill now abandoned, and replaced by numerous named tuffs (Bingler, 1978a), described in county area DOL-2.	Bingler, 1978a; Bonham, 1969
WS-3	Tt2	Santiago Canyon Tuff, two unnamed tuffs, Eureka Canyon Tuff, Nine Hill Tuff, Lenihan Canyon Tuff, Mickey Pass Tuff	Miocene and Oligocene	See description in county area DOL-2.	Bingler, 1977, 1978a; Moore, 1969; Thompson, 1956

WHITE PINE COUNTY (WP)					
WP-1	Tt1	Kalamazoo Volcanics of Young (1960)	Oligocene, 34 m.y.	Kalamazoo Volcanics, 2,000 to 3,500 ft thick, consists mostly of andesitic flows and lesser tuff and sedimentary rocks. Parts of Young's (1960) members 6, 5 and 2 may contain ash-flow tuff; member 1, as much as 350 ft thick, is an ash-flow unit.	Young, 1960
WP-2	Tt2	Bates Mountain Tuff, Pancake Summit Tuff, Windous Butte Formation	Oligocene	Bates Mountain Tuff consists of 3 welded ash-flow tuffs totaling 100 ft in thickness. The Pancake Summit Tuff (32 to 33 m.y.) is rhyolitic, 100 to 200 ft thick; Cook (1965) recognized more than 441 ft of the Windous Butte Formation near Pancake Summit; Windous Butte may be correlative with Pancake Summit Tuff.	Cook, 1965; Nolan and others, 1974
	Tt1	Pinto Peak Rhyolite, Pinto Basin Tuff Member	Oligocene, 33 to 34 m.y.	Pinto Basin Tuff Member of Pinto Peak Rhyolite is mainly vitric, air-fall, crystal-tuff, breccia and some tuffaceous sandstone.	
WP-3	Tt2	Pancake Summit Tuff, Stone Cabin Formation	Oligocene	Pancake Summit Tuff consists of two ash-flow members totaling 450 ft in thickness. Stone Cabin Formation is a rhyolitic ash-flow tuff consisting of at least two members several hundred feet thick.	Hose and others, 1976; Stewart and Carlson, 1978; Young, 1960
	Tt1	Older volcanic rocks	Oligocene	Hose and others (1976) show volcanic rocks in northern part of the area that may in part be correlative with the Kalamazoo Volcanics of Young (1960).	
WP-4	Tt1	Welded tuff	Tertiary	Siliceous, welded tuff, may be as thick as 800 ft, based on cross section by Brokaw and Heidrick (1966). Two outcrops in northeast part of area are ash beds.	Brokaw and Heidrick, 1966
WP-5	Tt2	Charcoal Ovens Tuff	Oligocene, 32 m.y.	The northern outcrop of this unit is rhyolitic welded tuff, which may be more than 400 ft thick, based on topographic contours on geologic map (Brokaw, 1967). Tuff in the southern outcrop, called the Charcoal Ovens Tuff (Hose and others, 1976), has 3 cooling units and a total thickness of 425 ft.	Brokaw, 1967; Hose and others, 1976

WP-6	Tt2	Charcoal Ovens(?) Tuff	Oligocene	May be Charcoal Ovens Tuff, based on data from Hose and others (1976), but Drewes (1967) mapped as rhyolitic lava.	Drewes, 1967; Hose and others, 1976
	Tt1	Unnamed tuff	Eocene	Latitic welded tuff, massive tuff, and tuff breccia. Welded tuff occurs in lens about 0.5 mi long and 100 ft thick. Massive tuff is about 1,900 ft thick, as measured on fence diagram by Drewes (1967).	
WP-7	Tt2	Shingle Pass Tuff, Needles Range Formation, Windous Butte Formation	Oligocene	Shingle Pass Tuff, 92 ft thick; Needles Range Formation, 53 ft thick; and Windous Butte Formation, 343 ft thick. Thicknesses from Cook (1965, Magnesite (Windous) section).	Cook, 1965; Hose and others, 1976
WP-8	Tt2	Shingle Pass Tuff, Needles Range Formation, Windous Butte Formation, and Stone Cabin Formation	Oligocene	Shingle Pass Tuff, 120 ft thick; Needles Range Formation, 103 ft thick; and Windous Butte Formation, 285 ft thick, and Stone Cabin Formation, about 800 ft thick. Thicknesses from Cook (1965, Milk Creek Canyon section).	Cook, 1965; Hose and others, 1976
WP-9	Tt2	Needles Range Formation	Oligocene, 29 to 31 m.y.	Rhyodacitic to quartz latitic, welded tuff in 2 cooling units, the upper welded, the lower nonwelded. Locally may be as much as 1,000 thick, based on topographic contours on geologic maps (Whitebread, 1969, 1982).	Hose and others, 1976; Whitebread, 1969, 1982; Whitebread and and others, 1962

PART B - CALDERAS AND CALDRONS

Name	Description	References
	CHURCHILL COUNTY	
Unnamed caldera	The distribution and shape of a densely welded tuff body (about 25 m.y. old), which is at least 2,000 ft thick, indicate a caldera in the central part of the Desatoya Mountains, in county area CH-4.	Stewart and Carlson, 1976; Stewart and McKee, 1977
Unnamed caldera	Located in southern Clan Alpine Mountains in county area CH-5. Area was site of voluminous, silicic volcanism between 24 and 30 m.y. ago, and extrusion was concurrent with faulting and subsidence. A caldera probably formed but has not been completely delineated.	Riehle and others, 1972
Volcano-tectonic trough	Thick prism of lower Miocene and upper Oligocene volcanic rocks fills a broad east-trending trough in south-central Churchill County. In Shoshone Range, at its eastern end, at least 3,280 ft of volcanic rocks (26 to 30 m.y.) fill the trough. Volcanic rocks in the trough in the Desatoya Mountains are 24 to 25 m.y. old. In the central part of Clan Alpine Mountains, gravity data indicate volcanic rocks are 9,800 to 16,400 ft thick; volcanism occurred in two pulses 24 to 25 m.y. and 29 to 30 m.y. ago. The northern boundary of the trough in the Clan Alpine Mountains is delineated by a normal fault with at least 3,940 ft of vertical offset. In the Stillwater Range, at the west end of the trough, volcanic rocks are 9,800 ft thick, Oligocene in age, and, in part, are equivalent to volcanic sequence in Clan Alpine Mountains. The compositional diversity and age range of rock units within the trough indicate that the volcanic rocks accumulated during formation of several overlapping calderas.	Burke and McKee, 1979
	ESMERALDA COUNTY	
Fraction caldera	Formed with eruption of Fraction Tuff. Tuff is about 2,000 ft thick, hydrothermally altered, and locally mineralized with silver and gold. Caldera structure poorly defined; outline inferred by authors of this report.	Bonham and Garside, 1979
Goldfield caldera	Ring fracture formed with eruption of Oligocene tuff (about 30 to 31 m.y.); associated collapse probably minor or non-existent. During the Miocene (about 22 m.y.) faulting, hydrothermal alteration, and ore deposition accompanied emplacement of a shallow pluton. Several episodes of doming are recognized as beginning in the Oligocene and continuing intermittently into Pliocene. The ore deposits consist of gold and silver.	Albers and Cornwall, 1966; Albers and Kleinhampl, 1970; Ashley, 1972, 1974

Monte Cristo and Gilbert calderas	Reconnaissance mapping indicates Monte Cristo caldera formed by eruption of the tuff of Castle Peak; exact age uncertain but older than 15 m.y. The smaller Gilbert caldera may have formed during the same eruptive cycle as the Monte Cristo caldera.	Moore, 1981; J. H. Stewart, U.S. Geological Survey, written commun., 1982
Silver Peak caldera	Formed about 6 m.y. ago with the eruption of rhyolite tuff. Intracaldera tuffs are as much as 2,000 ft thick, intensely hydrothermally altered, and locally mineralized with silver. Alteration was greatest in north-central part and along eastern margin of caldera.	Robinson, 1968, 1972; Robinson and others, 1968, 1976; Stewart and others, 1974
	EUREKA COUNTY	
Unnamed caldera	Located in southwestern Eureka County in county area EU-4.	Albers and Kleinhampl, 1970; Stewart and Carlson, 1976
	HUMBOLDT COUNTY	
Calderas of McDermitt volcanic field:	Volcanic field formed in Nevada and southern Oregon 16.1 to 15 m.y. ago with eruption of 7 large-volume ash-flow sheets. Eruption of each sheet resulted in a large collapse caldera. Area mineralized with mercury, antimony, cesium, lithium, and uranium.	Greene, 1972, 1976; Plouff, 1976; Rytuba, 1976; Rytuba, Conrad, and Glanzman, 1979; Rytuba and Glanzman, 1978; Rytuba, Glanzman, and Conrad, 1979; Rytuba and McKee, 1984
Whitehorse caldera (in Oregon)	Formed with eruption of tuff of Whitehorse (15.0 m.y.). Not shown on map.	
Hoppin Peaks caldera	Formed with eruption of tuff of Hoppin Peaks (15.5 m.y.), outflow facies as much as 295 ft thick; ring fracture on west side exposed; caldera outlined by gravity low.	
Long Ridge caldera	Formed with eruption of tuff of Long Ridge, member 5 (15.6 m.y.); minimum intracaldera thickness 985 ft; circular resurgent dome present in central part of caldera.	
Jordan Meadow caldera	Formed with eruption of tuff of Long Ridge, members 2 and 3 (15.6 m.y.); maximum thickness 754 ft.	
Calavera caldera	Formed with eruption of tuff of Double H (15.7 m.y.); intracaldera thickness more than 985 ft.	

Pueblo caldera (in Oregon)	Formed with eruption of tuff of Trout Creek Mountains (15.8 m.y). Not shown on map.	
Washburn caldera	Formed with eruption of tuff of Oregon Canyon (16.1 m.y.), as much as 330 ft thick.	
Unnamed calderas	Three calderas are inferred in western Humboldt and adjacent Washoe Counties. The largest caldera, at northern end of county area H-2, coincides with a gravity and aeromagnetic low; the Soldier Meadow Tuff may have erupted from vents related to largest caldera. The smallest caldera, (near Rock Spring Table) adjacent to county area H-4, coincides with a gravity low, and an unnamed caldera in central part of county area H-2 coincides with an aeromagnetic low.	Cathrall and others, 1978; Greene and Plouff, 1981; Korringa, 1973;

LANDER COUNTY

Fish Creek Mountains caldera	Formed with eruption of the Fish Creek Mountains Tuff (24.3±0.7 m.y.), which is about 3,000 ft thick within the caldera and characterized by large zones of alteration. The central core of the caldera may have been resurgently domed. The caldera bisects a long volcano-tectonic trough that extends across central Lander County.	McKee, 1970; Stewart and McKee, 1977
Mount Lewis caldera	Formed with eruption of part of the Caetano Tuff (32.4 m.y.); the remainder of the tuff probably came from the volcano-tectonic trough centered about 16 mi to the south. Aeromagnetic high centered in southwestern part of caldera where subsidence was at least 3,100 ft. Meager evidence of mild resurgent doming; caldera is deeply eroded.	Wrucke and Silberman, 1975
Unnamed caldera	Located in northern part of Toiyabe Range, in county area LA-5. Probable source of tuff of Hall Creek, which locally may be about 2,000 ft thick. The tuff is undated but is overlain by Caetano Tuff (32.5 m.y.) in most places.	Stewart and Carlson, 1976; Stewart and McKee, 1977
Volcano-tectonic trough	Thick prism of Oligocene volcanic and sedimentary rock fill an east-trending trough in central Lander and southeastern Pershing Counties; high-angle faults produce sharp trough boundaries. The Caetano Tuff (about 33 m.y. old), principal unit of the trough fill, is at least 8,000 ft thick in the Toiyabe Range, at least 5,000 ft thick and pervasively argillically altered and faulted in the Shoshone Range, and 1,640 to 1,970 ft thick in the Tobin Range. Trough is breached in the western part by the Fish Creek Mountains caldera.	Burke and McKee, 1979; Gilluly and Masursky, 1965; Masursky, 1960; Stewart and McKee, 1977

LINCOLN COUNTY		
Bald Mountain caldron	Deeply eroded caldron contains 2 or more rhyolitic ash-flow tuffs comprising the tuff of Bald Mountain (about 25 m.y.); the tuff generally is moderately to intensely hydrothermally altered. A normal fault of large displacement cuts the caldron on the west side. The tuff of Bald Mountain is not present east of the Groom Range.	Ekren and others, 1977
Caliente caldron complex	The complex is ringed by Tertiary granitic intrusives and magnetic highs that indicate buried intrusives. The complex includes a large gravity low in the Clover Mountains. Boundaries of the caldera are entirely buried by post-caldron lavas, tuffs, and alluvium, except on the west side where a lobe of the complex has resurged. The eastern boundary is poorly defined, and the complex could extend into Utah. Probable source of Hiko Tuff, Harmony Hills Tuff, and Racer Canyon and Ox Valley Tuffs. See county area LI-19 for lithologic description of individual tuffs. Thick sedimentary sequences in the complex probably reflect volcano-tectonic subsidence.	Cook, 1960; Ekren and others, 1977; Noble and McKee, 1972; Noble, McKee, and others, 1968
Kane Springs Wash caldera	Formed with eruption of Kane Wash Tuff (14 m.y.), about 1,000 ft thick; minimum subsidence of 1,640 ft. Magmatic resurgence formed extrusive complex within the caldera. Basin-range faulting tilted caldera about 5° southeastward. Minor hydrothermal alteration.	Ekren and others, 1977; Noble, 1968; Novak, 1984
NYE COUNTY, NORTHERN HALF		
Big Ten Peak caldera and unnamed caldera to the south	Presence indicated by great thickness of tuff and by complexities of faulting and intrusion. Big Ten Peak caldera formed with eruption of tuffs of Rye Patch, which are greater than 1,640 ft thick in the caldera and are probably about 26 m.y. old. Coalescing calderas that could be partially concealed beneath Quaternary alluvium may be present in the vicinity, but remain unidentified.	Bonham and Garside, 1979; Kleinhampl and Ziony, 1985
Darrough caldera	Darrough Felsite (22 to 26 m.y. or older) is a very compacted tuff pile that accumulated in the Darrough caldera. Tuff pervasively altered and silicified; exposed thickness more than 6,560 ft; total thickness probably much greater.	Kleinhampl and Ziony, 1985; Speed and McKee, 1976
Hot Creek Valley caldera complex	Part of a large area of volcanic subsidence.	Ekren, Hinrichs, and others, 1973; Ekren and others, 1976; U.S. Geological Survey, 1970
Lunar Lake caldera	Formed following eruption of tuff of Lunar Cuesta about 25 m.y. ago; central part of caldera probably subsided between 1,000 to 2,000 ft.	Ekren, Hinrichs, and others, 1973; Ekren and others, 1972, 1976; Ekren, Quinlivan and others, 1974; Quinlivan and others, 1974

Manhattan caldera	Formed with eruption of 25-m.y.-old tuffs; thickness of sequence may exceed 6,580 ft. Gravity and aeromagnetic lows coincide with the caldera.	Healey and others, 1981; D.R. Shawe, U.S. Geological Survey, written commun. 1985
Moores Creek caldera	See Mount Jefferson caldera complex for description.	
Mount Jefferson caldera complex	Complex consists of 3 overlapping volcanic collapse structures, Moores Creek, Mount Jefferson, and Trail Canyon. Moores Creek caldera is 27 m.y. old; Mount Jefferson caldera, 25.8 m.y. old and filled with at least 6,560 ft of tuff of Mount Jefferson; Trail Canyon caldera, 22.3 m.y. old. A possible resurgent core is associated with Mount Jefferson caldera and margins of the caldera are locally altered and mineralized.	Boden and Harrington, 1984; Kleinhampl and Ziony, 1985
Northumberland caldera	Formed by eruption of Northumberland Tuff (32.3±1 m.y.) which is at least 1,000 ft thick in the caldera.	McKee, 1974, 1976b
Pancake Range caldera	Poorly defined caldera in southern part of Pancake Range; part of central Nevada caldron complex.	Ekren and others, 1972, 1974, 1976; Ekren, Quinlivan, and others, 1974; U.S. Geological Survey, 1970
Peavine caldera	Tertiary silicic ash-flow tuffs and intrusive bodies and associated sedimentary strata and breccia form a structurally complex volcanic center. Inferred Peavine caldera is part of volcanic center; tuffs of Peavine Canyon of Kleinhampl and Ziony (1985) are greater than 700 ft thick in the area. A mercury mine is associated with mineralized, highly sheared and fractured zone along northern boundary.	Brem and Snyder, 1983; Kleinhampl and Ziony, 1985
Quinn Canyon Range caldron	Quinn Canyon Range is resurged central part of a large caldera; however, it is uncertain which tuffs were extruded from the center. Rocks in the range are intensely fractured and faulted, locally intensely hydrothermally altered, and mineralized with fluorite.	Ekren and others, 1977
Trail Canyon caldera	See Mount Jefferson caldera complex for description.	
Unnamed caldera	Located in county area NN-15 west of Peavine caldera.	Stewart and Carlson, 1976
Unnamed caldron	Located partly within county area NN-17 in northwestern part of northern Nye County. Intracaldron tuffs of Gabbs Valley along western margin are about 1,000 ft thick; uranium and other metallic deposits also occur in area.	Ekren and Byers, 1976; Kleinhampl and Ziony, 1985

Williams Ridge caldera	Probably formed with the extrusion of Windous Butte Formation (Oligocene). Caldera is filled with the tuff of Williams Ridge and Morey Peak (31.4 to 31.8 m.y.), which is more than 6,500 ft thick.	Dixon and others, 1972; Ekren and others, 1976; Ekren, Hinrichs, and others, 1973; Quinlivan and others, 1974

NYE COUNTY, SOUTHERN HALF

Black Mountain caldera	Compound structure related to eruption of 5 ash-flow tuff sheets and intervening lava and tuff units. Caldera collapse probably followed eruption of each of the 4 oldest ash-flow sheets of the Thirsty Canyon Tuff, but structural evidence for only two of these calderas is clear. Resurgence that formed a central volcanic complex may have occurred near the middle of the eruptive cycle.	Byers, Carr, Christiansen, and others, 1976; Christiansen and Noble, 1968; Cornwall, 1972; Crowe and Sargent, 1979; Ekren and others, 1971; Noble and Christiansen, 1968, 1974
Cathedral Ridge caldera	Filled with about 7,200 ft of Fraction Tuff (17.8 m.y.).	Ekren and others, 1971; Rogers and others, 1967
Claim Canyon caldera	See Timber Mountain-Oasis Valley caldera complex for description.	
Crater Flat - Prospector Pass caldera complex	Probable source of Crater Flat Tuff (13.5 m.y.average) which is more than 1,500 ft thick. Crater Flat is a large, compound, gravity low, which is a southward extension of a regional gravity low associated with the Timber Mountain-Oasis Valley caldera complex to the north. Gravity data indicate more than 10,000 ft of volcanic and Tertiary sedimentary rocks in the Crater Flat depression and aeromagetic data indicate several possible resurgent domes. Because of complex structure and hydrothermal alteration, especially in northern part of Prospector Pass segment, geophysical evidence of the caldera structure is tenuous.	Carr, 1982; Carr and others, 1984
Kawich caldera	Source of tuff of Kawich caldera (22 to 25 m.y.) which is at least 3,000 ft thick and overlain by intracaldera tuffs of Kawich Peak, which have a maximum thickness of about 1,000 ft. Upper part of tuff of Kawich caldera extensively hydrothermally altered. Caldera margin poorly preserved because of dissection and offset along northwest-trending faults. Magma resurgence occurred in late Oligocene.	Ekren and others, 1976; Gardner and others, 1980

Mount Helen caldera	Probable source of the tuff of Tolicha Peak (late Miocene). Collapse may have been recurrent during eruption of the 3 tuff members.	Ekren and others, 1971
Oasis Valley caldera	See Timber Mountain-Oasis Valley caldera complex for description.	
Silent Canyon caldera	Initial collapse probably followed eruption of Tub Spring Member of Belted Range Tuff and collapse continued with eruption of Grouse Canyon Member (13.8±0.5 m.y.). Additional collapse accompained extrusion of younger tuffs and lavas from a different magma source than that of the Belted Range Tuff but probably still within the boundary of the Silent Canyon caldera. Subsidence of 5,000 to 7,000 ft within the caldera indicated by drilling records. Gravity low beneath eastern Pahute Mesa.	Crowe and Sargent, 1979; Noble, Sargent, and others, 1968; Orkild and others, 1968, 1969
Sleeping Butte caldera	See Timber Mountain-Oasis Valley caldera complex for description.	
Stonewall Mountain caldera	Formed during at least 2 episodes of collapse following eruption of 2 ash-flow tuff sheets with combined thickness of at least 1,970 ft. Tuffs comprise Stonewall Flat Tuff dated at 6.3 m.y. (Noble and others, 1984); however, age conflicts with date on intrusives in the volcanic pile of 7.4 to 8.4 m.y. (Foley and Sutter, 1978).	Foley and Sutter, 1978; Noble and others, 1984
Timber Mountain-Oasis Valley caldera complex:		
Sleeping Butte caldera	Possibly formed by collapse associated with Redrock Valley Tuff (15.7 m.y.), the oldest ash-flow tuff related to the Timber Mountain-Oasis Valley caldera complex.	Byers and others, 1966; Byers, Carr Orkild and others, 1976;
Claim Canyon caldera	Formed with eruption of the Paintbrush Tuff (12.5 to 13.2 m.y.); intracaldera thickness more than 6,500 ft. May have been resurgently domed, but some disagreement on this by various workers.	Byers and Cummings, 1967; Carr, 1964; Carr and Quinlivan, 1966; Christiansen and others, 1965, 1977;
Timber Mountain and Oasis Valley calderas	After eruption of the Paintbrush Tuff there was broad doming and extrusion of lava flows (11.3 to 12 m.y.). Eruption of the Rainier Mesa Member (11.3 m.y.) of the Timber Mountain Tuff was accompanied by multiple collapse and formation of a large caldera depression, which included the Timber Mountain and probably the Oasis Valley calderas. The Timber Mountain caldera then subsided with eruption of both the Ammonia Tanks Member (11.1 m.y.) and the tuff of Buttonhook Wash of the Timber Mountain Tuff. Central resurgence (about 11 m.y.) formed the Timber Mountain dome.	Hinrichs and others, 1967; Lipman and others, 1966; O'Conner and others, 1966; Orkild and others, 1969

Unnamed caldera	In county area NS-3, partly exposed along east flank of Reveille Range; formed by eruption of Monotony Tuff (24 to 27 m.y.). Caldera boundary discontinuous probably due to lateral fault movement.	Ekren, Rogers and Dixon, 1973; Kleinhampl and Ziony, 1985

PERSHING COUNTY

Ragged Top caldera	Source of lava flows and welded tuffs called dacite but of rhyolitic composition; caldera and its extrusive products are of Miocene age (12.7 m.y.). Interior of caldera occupied by generally massive, dacite microbreccia cut by numerous latite and dacite dikes.	Willden and Speed, 1974
Volcano-tectonic trough	See description of volcano-tectonic trough under Lander County.	

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