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Density and Magnetic Susceptibility Measurements of Igneous Rocks from the Marysvale Volcanic Field, West-Central Utah

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.

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Introduction and geologic setting

The Marysvale volcanic field is located in west-central Utah and is one of several volcanic fields surrounding the Colorado Plateau. It has a petrologic history generally similar to other volcanic fields in the western United States, in that it contains early-erupted, voluminous, intermediate-composition volcanic rocks followed by a bimodal assemblage of alkali rhyolites and local basalts. The data in this report are intended to be used with published maps of the geology, alteration, Bouguer gravity anomalies, and aeromagnetics (Cunningham and others, 1982a, 1982b; Cook and others, 1982; Campbell and others, 1982) to understand the subsurface geological relationships. The data also apply in a general sense to other volcanic fields because of the general similarities in rock types and the process that formed them.

The intermediate-composition volcanic rocks were erupted from about 35 m.y. ago to about 22 m.y. ago from scattered stratovolcanoes. Many of these rocks are hornblende-biotite-bearing, calc-alkalic rocks of the Bullion Canyon Volcanics. Ash-flow tuffs were erupted from local sources resulting in the formation of calderas throughout the volcanic field.

The most voluminous rocks in the bimodal suite are the crystal-poor alkali-rhyolite ash-flow tuffs and lava flows of the Mount Belknap Volcanics. The Joe Lott Tuff Member is a widespread ash-flow tuff that varies in its degree of welding. Its eruption resulted in the formation of the Mount Belknap caldera. The mafic end of the bimodal suite is represented by basalts, erupted from scattered sources. The first basalts, erupted about 22 m.y. ago, have a unique composition and are termed potassium-rich mafic lavas.

Altered rocks, including both the older and younger rocks, are widespread in the volcanic field and are often associated with known or potential ore deposits. Many of the intermediate-composition rocks have been pervasively propylitically altered and thus have been described in this report as "slightly altered." Rocks that contain some argillic alteration are termed "moderately altered" and rocks that have advanced argillic alteration, especially alunite, are termed "highly altered."

A suite of 88 igneous rocks was selected for this study and represents the time-space-composition variations present in the rocks of the volcanic field. The dry bulk densities and magnetic susceptibilities of these samples were measured; these measurements are shown in table 1 together with sample locations and petrologic descriptions. The results are depicted graphically in figures 1-10 and numerically in tables 2 and 3.

Dry bulk densities were measured using the buoyancy method which is based on Archimedes' principle (Johnson, 1979). First, the samples were weighed dry (dry weight = W_d), then water saturated in a vacuum chamber for 48 hours, and finally weighed while submerged in water of density ρ_w (submerged weight = W_w). The bulk volume (V_b) was determined by $V_b = W_w/\rho_w$, and the dry bulk density (ρ_b) was determined by $\rho_b = W_d/V_b = (W_d\rho_w)/W_w$.

Magnetic susceptibilities were measured using a balanced-arm induction bridge of the type described by Christie and Symons (1969). This bridge has identical Helmholz coils in each arm which are wound on 4" (10.16 cm) frames.

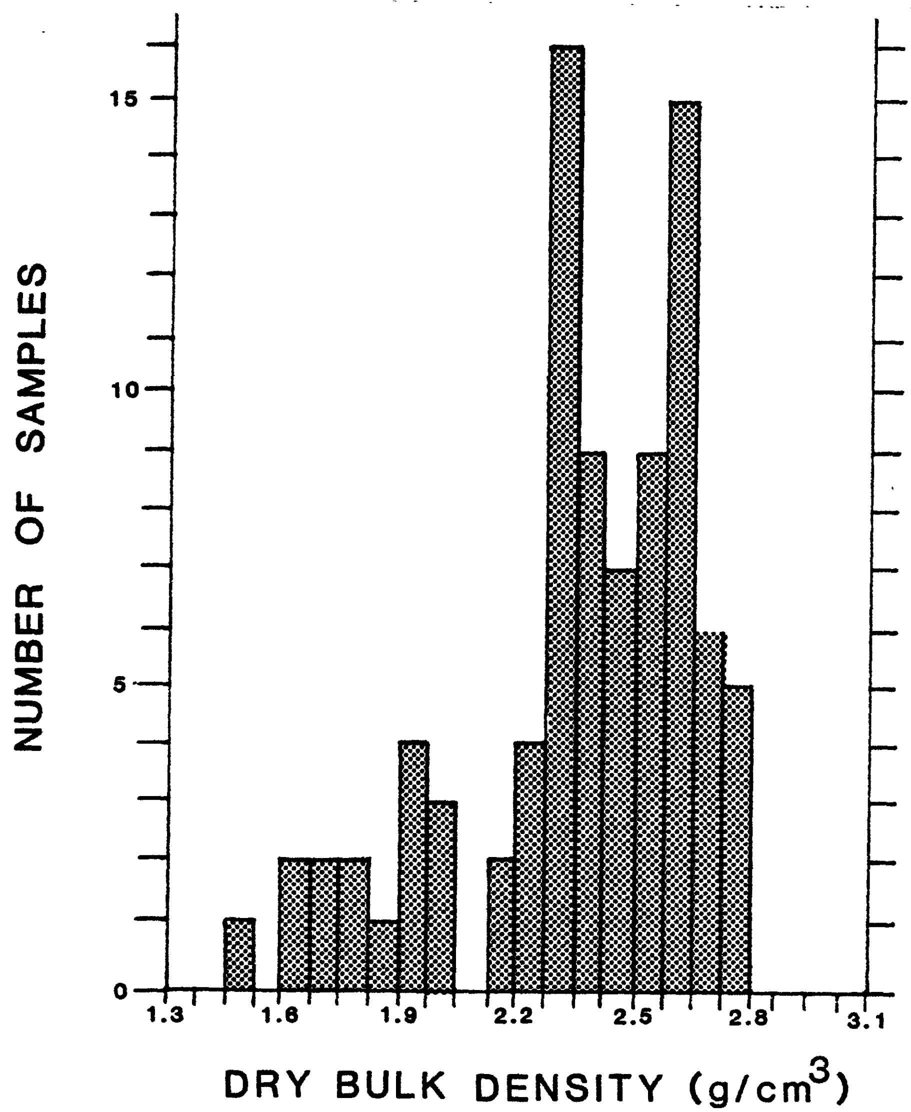

Figure 1.--Composite histogram of measured dry bulk densities of 88 igneous rock samples from the Marysvale volcanic field, Utah.

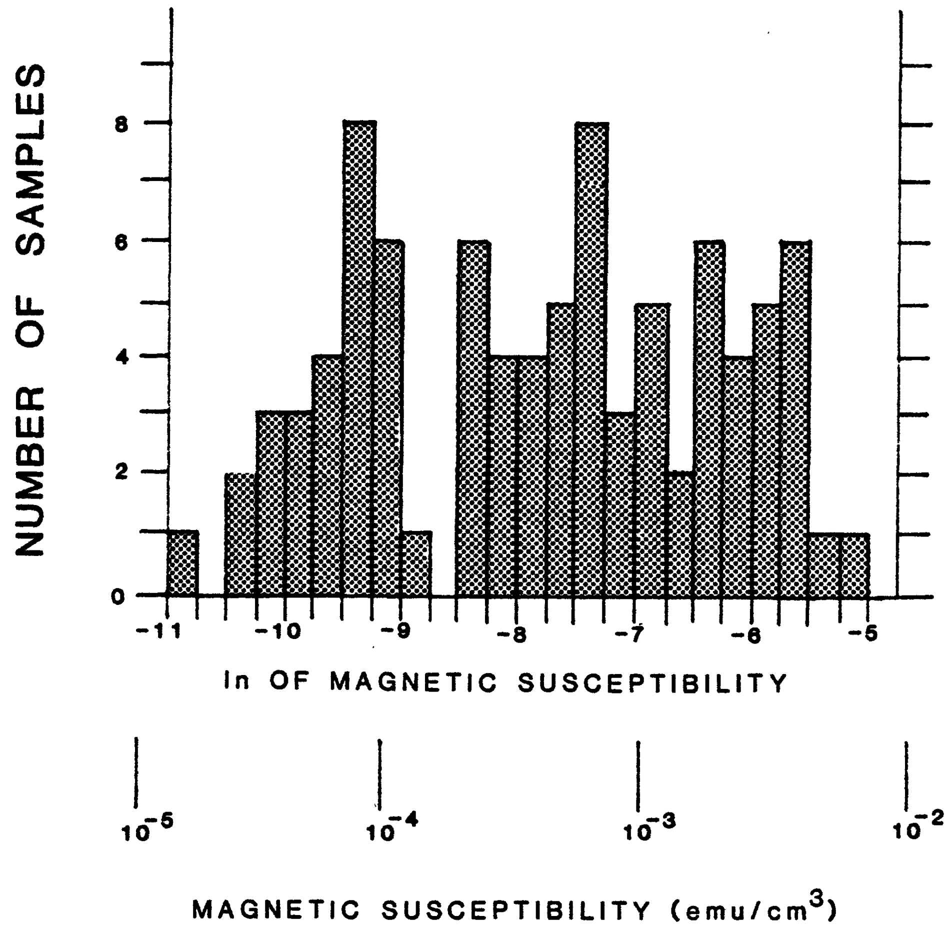

Figure 2.--Composite histogram of measured magnetic susceptibilities of 88 igneous rock samples from the Marysvale volcanic field, Utah.

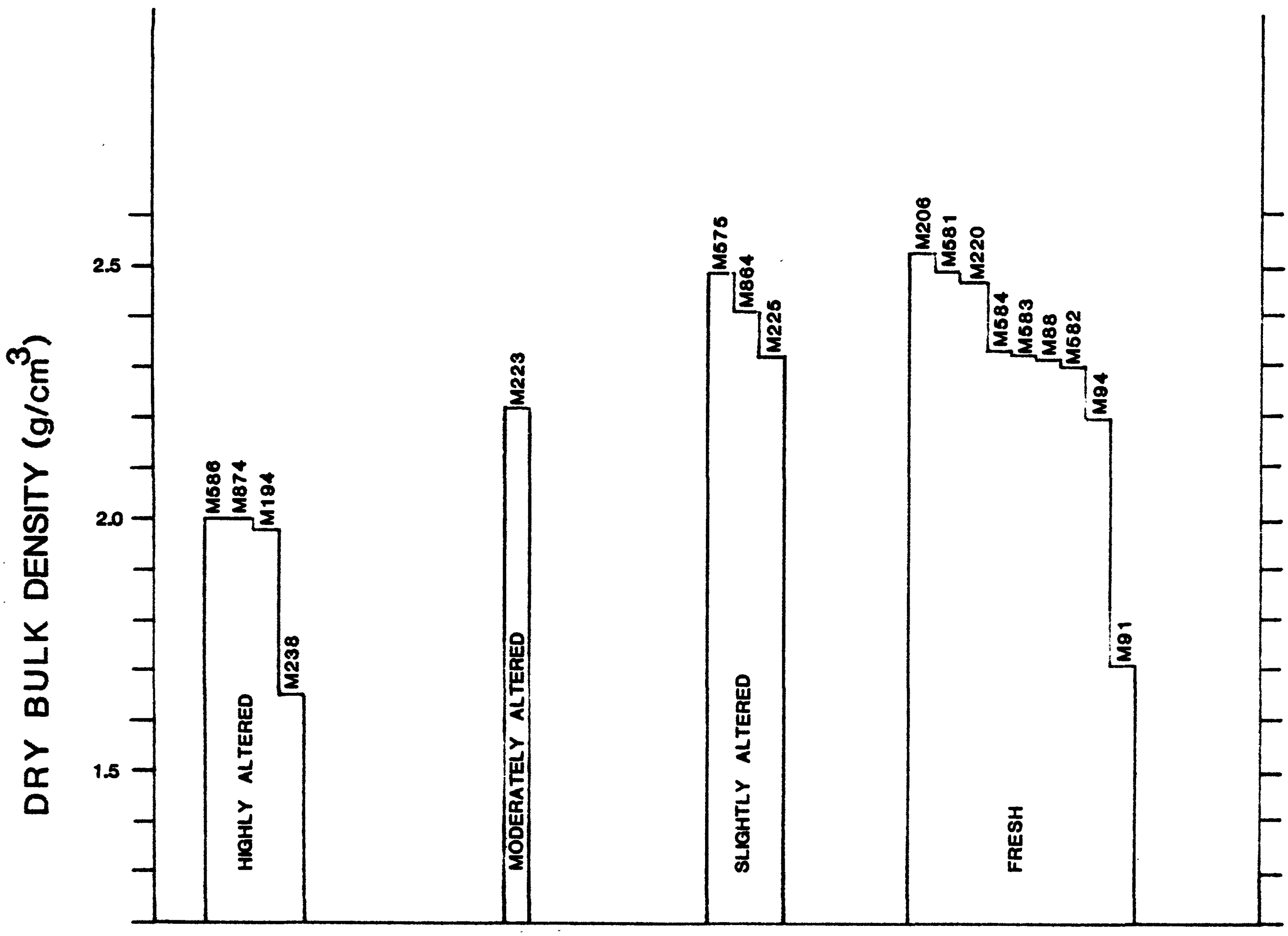

Figure 3.--Variation in measured dry bulk densities for fresh, slightly altered, moderately altered, and highly altered Mount Belknap Volcanics rocks from the Marysvale volcanic field, Utah.

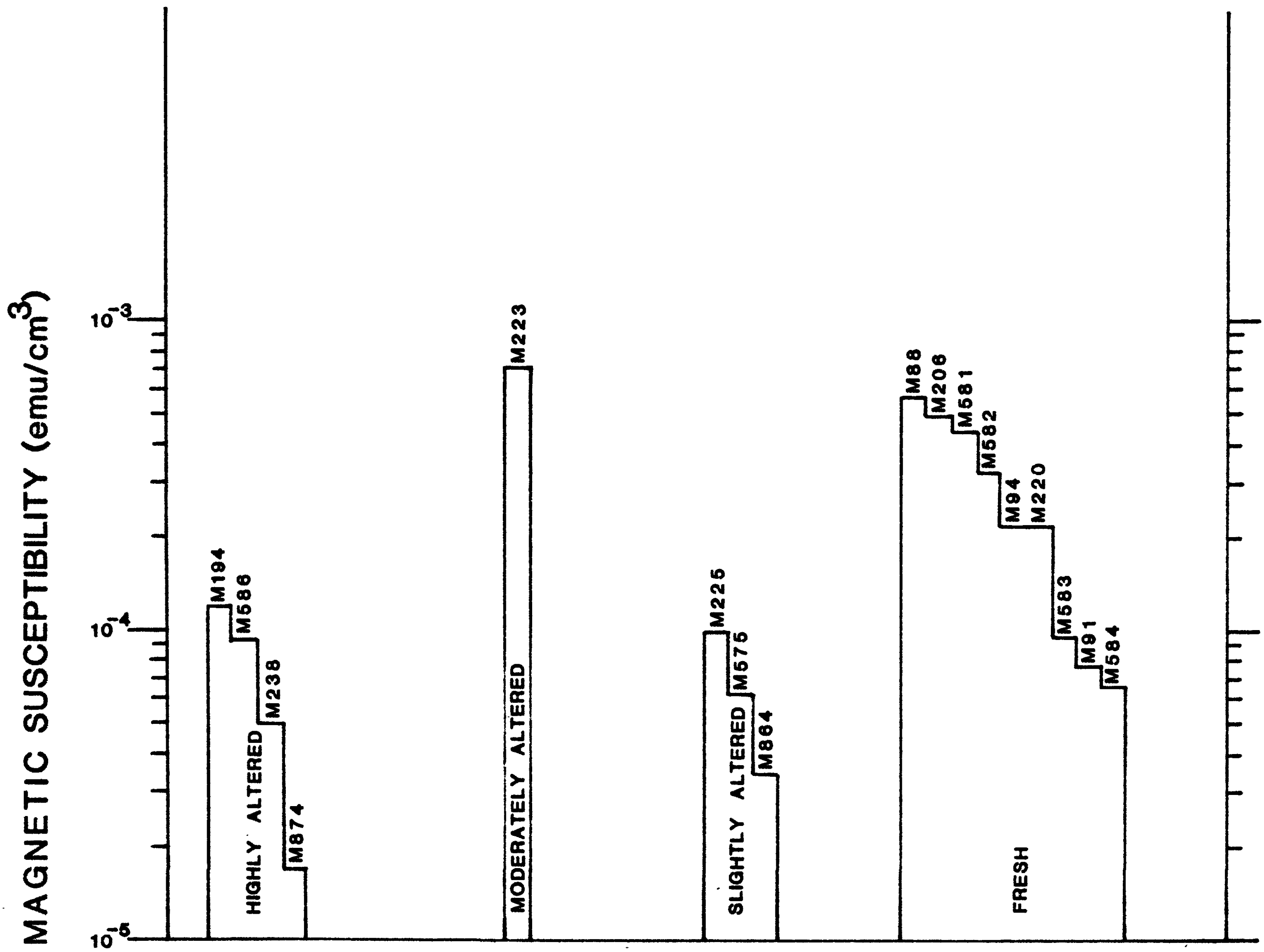

Figure 4.--Variation in measured magnetic susceptibilities from fresh, slightly altered, moderately altered, and highly altered Mount Belknap Volcanics rocks from the Marysvale volcanic field, Utah.

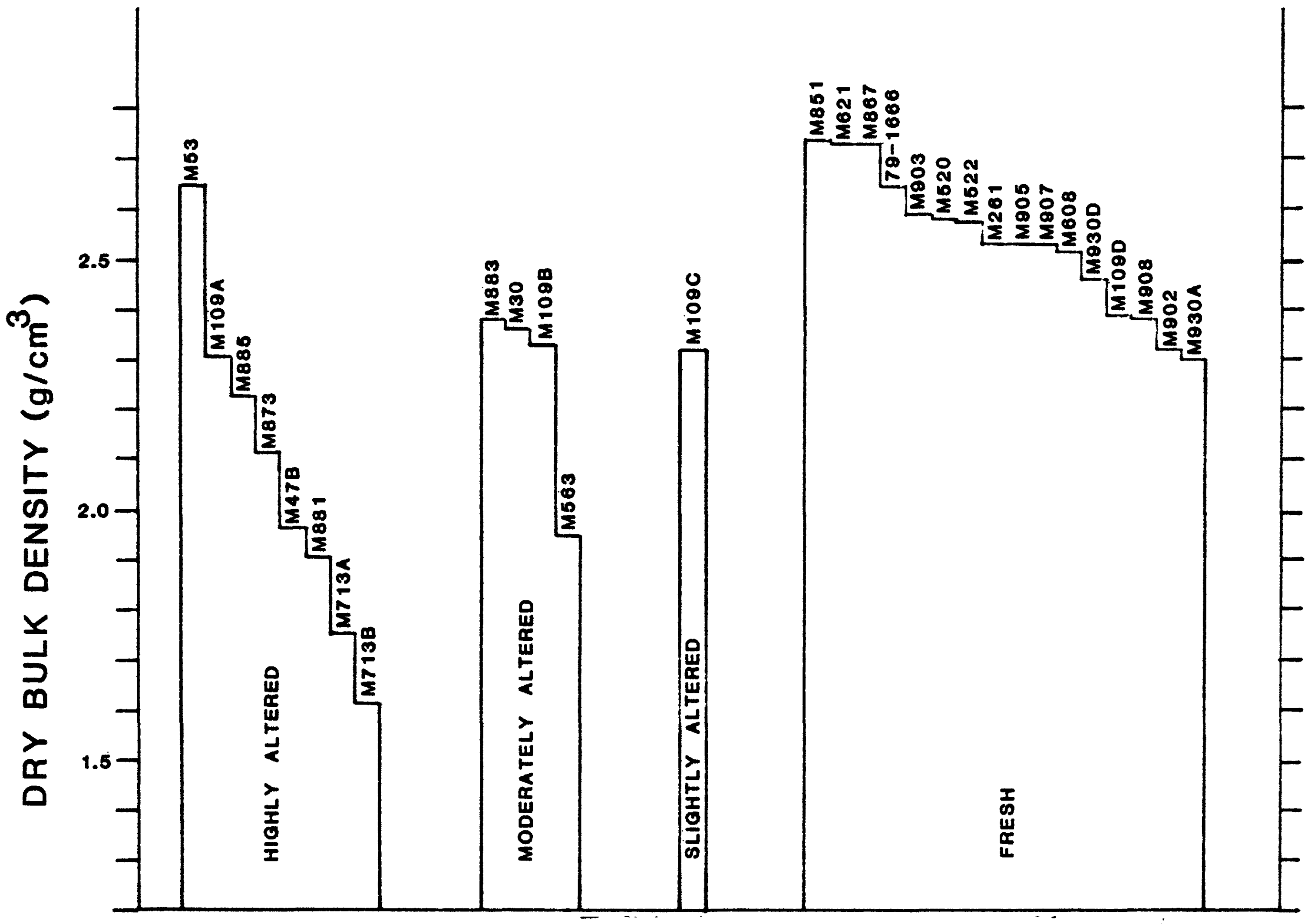

Figure 5.--Variation in measured dry bulk densities for fresh, slightly altered, moderately altered, and highly altered Bullion Canyon Volcanics rocks from the Marysvale volcanic field, Utah.

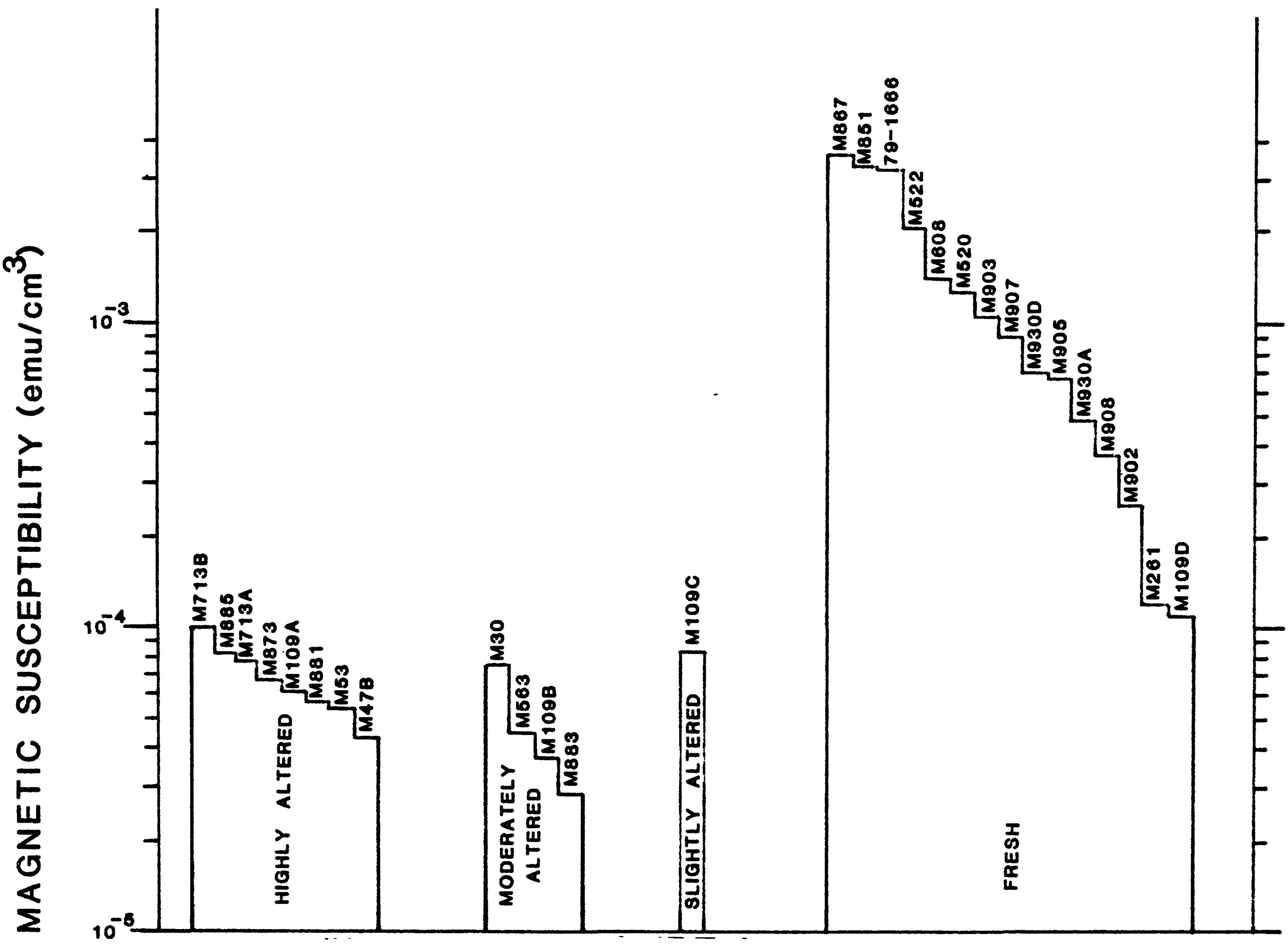

Figure 6.--Variation in measured magnetic susceptibilities for fresh, slightly altered, moderately altered, and highly altered Bullion Canyon Volcanics rocks from the Marysvale volcanic field, Utah.

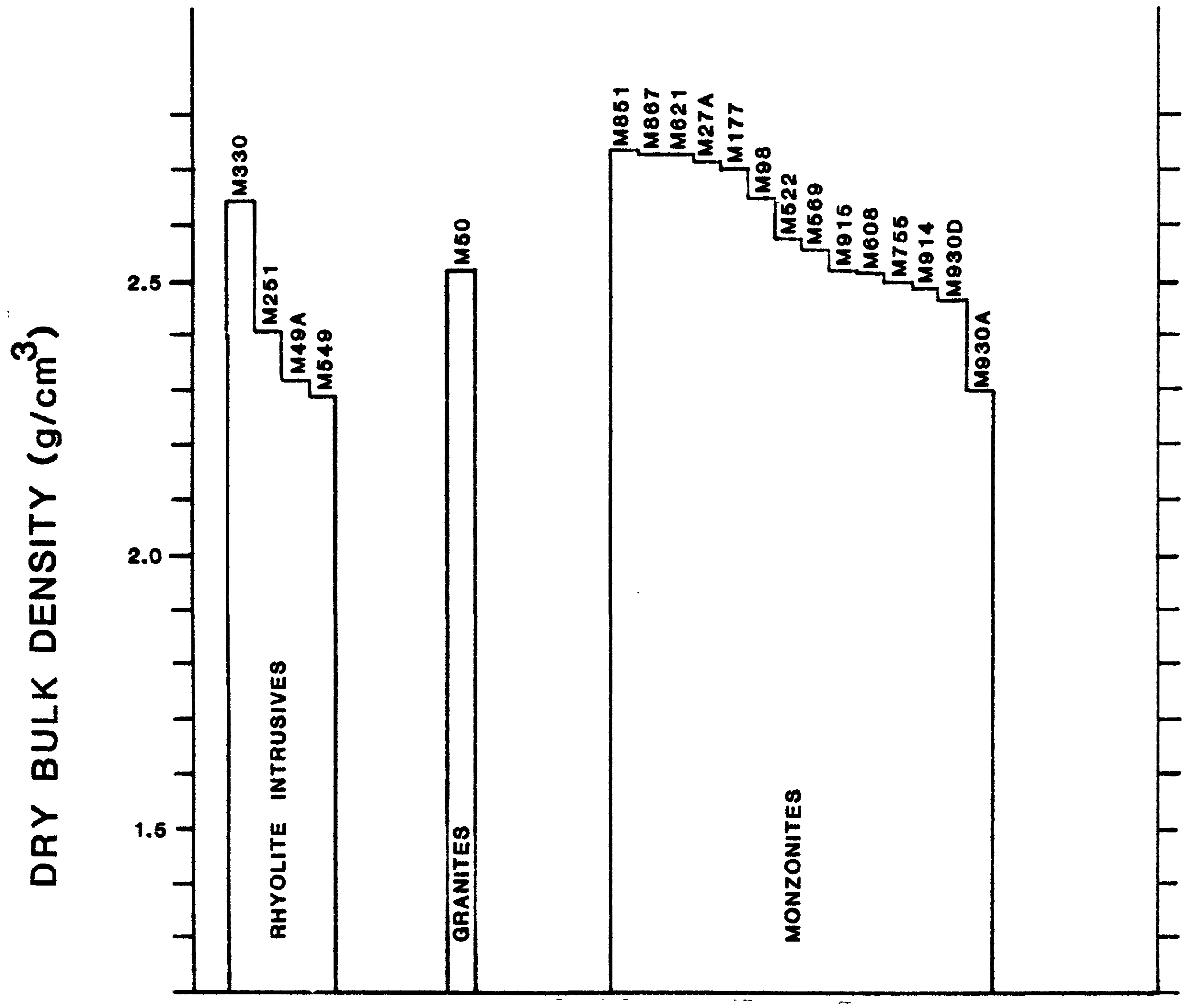

Figure 7.--Variation in measured dry bulk densities for intrusive rocks from the Marysvale volcanic field, Utah.

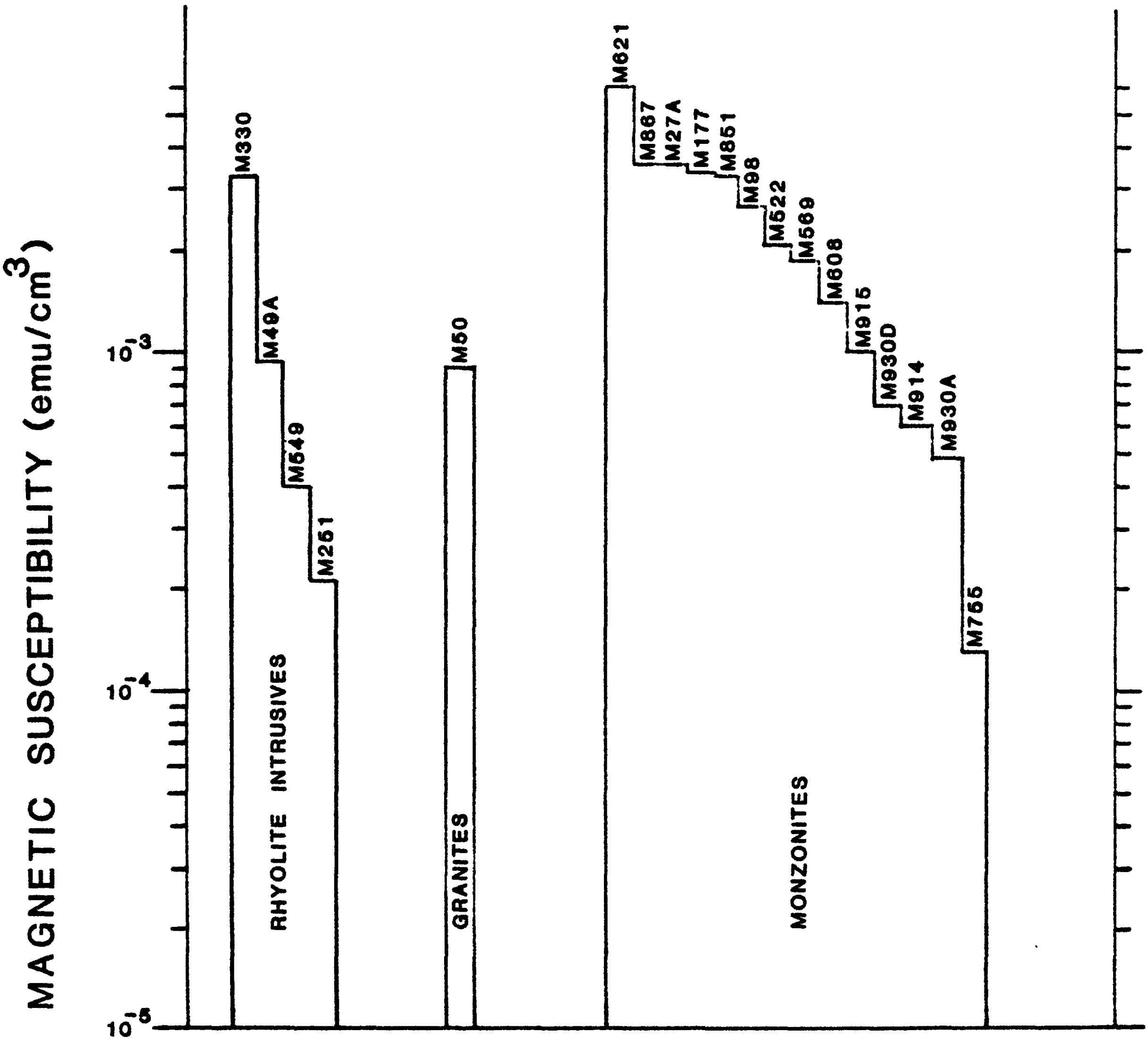

Figure 8.--Variation in measured magnetic susceptibilities for intrusive rocks from the Marysvale volcanic field, Utah.

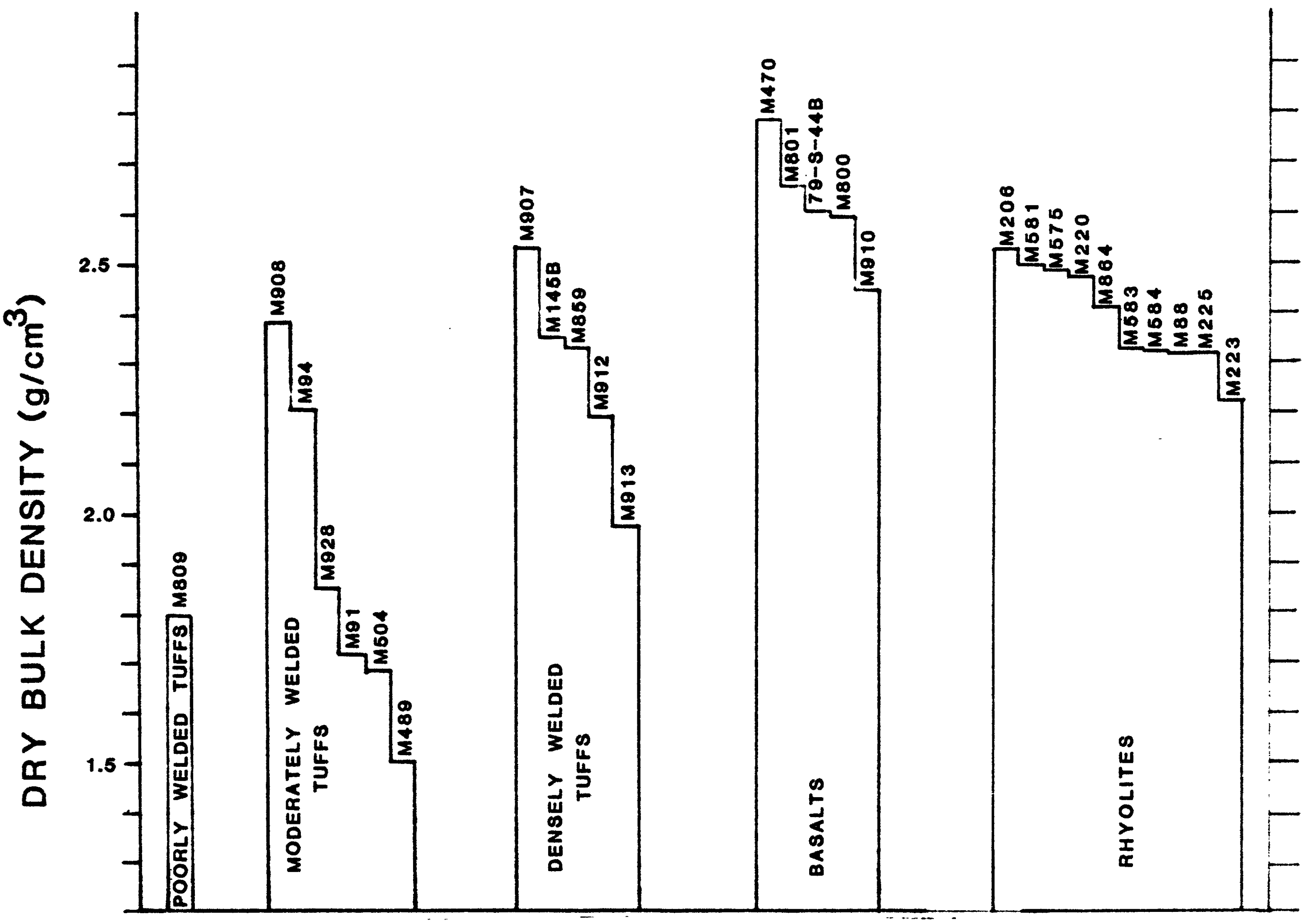

Figure 9.--Variation in measured dry bulk densities for extrusive rocks from the Marysvale volcanic field, Utah.

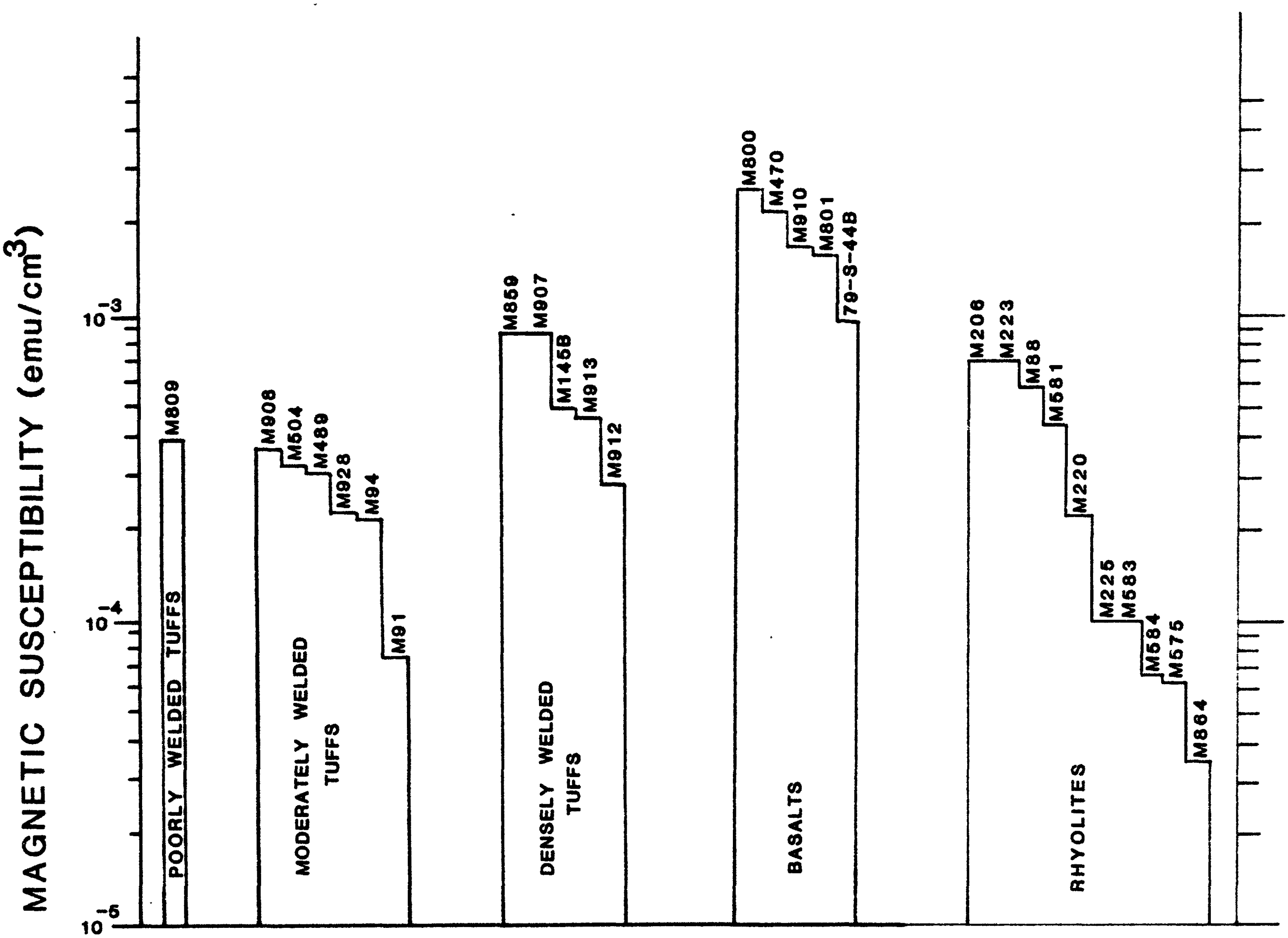

Figure 10.--Variation in measured magnetic susceptibilities for extrusive rocks from the Marysvale volcanic field, Utah.

Table 1.—Magnetic susceptibility, dry bulk density, location, and description of igneous rock samples from the Marysvale volcanic field, Utah

Sample No.	Rock Unit	Latitude	Longitude	Magnetic Susceptibility, in e.m.u./cm^3 (All values x10^{-3})	ρ_b Dry Bulk Density, in g/cm^3
M27A	Fresh quartz monzonite (Tbi), collected from the central intrusive near the Freedom Mine.	38°29'45" N.	112°12'47" W.	3.55	2.721
M30	Altered, dense, pink, alunitized Bullion Canyon Volcanics lava flow (Tb), collected from the Whitehorse Mine.	38°28'25" N.	112°11'27" W.	0.075	2.366
M47B	Highly altered, alunitized Bullion Canyon Volcanics lava flow (Tb), collected from the Yellow Jacket Mine.	38°32'04" N.	112°12'30" W.	0.043	1.969
M49A	Devitrified, crystal-rich rhyolite intrusive (Tmi), collected from the Teacup dome.	38°30'41" N.	112°10'35" W.	0.94	2.319
M50	Fresh, fine-grained granite (Tmf), collected from the north end of the Central Mining Area.	38°30'24" N.	112°13'10" W.	0.90	2.520
M53	Highly altered, alunitized Bullion Canyon Volcanics lava flow (Tb), collected from the Winkleman Mine.	38°29'38" N.	112°17'32" W.	0.052	2.652
M75	Devitrified, crystal-rich tuff member of the Mount Belknap Volcanics (Tmc), collected along Beaver Creek, 1.45 km west of the junction of Beaver Creek and the Sevier River.	38°28'37" N.	112°14'57" W.	0.61	2.419
M88	Fresh Gray Hills Rhyolite Member of the Mount Belknap Volcanics (Tmg), collected 2.57 km west-northwest of the junction of Beaver Creek and the Sevier River.	38°29'05" N.	112°15'35" W.	0.58	2.316
M91	Fresh, moderately welded Joe Lott Tuff Member of the Mount Belknap Volcanics (Tmj), collected from a road cut along Clear Creek, 3.14 km west of the junction of Clear Creek and the Sevier River.	38°34'50" N.	112°17'31" W.	0.077	1.715
M94	Fresh, moderately welded Joe Lott Tuff Member of the Mount Belknap Volcanics (Tmj), collected from a road cut on U.S. Highway 89, on south side of rest area alongside Deer Creek.	38°30'08" N.	112°15'24" W.	0.22	2.204
M98	Fresh quartz monzonite (Tbi), collected on Tip Top near the Sevier Mine.	38°29'20" N.	112°24'31" W.	2.69	2.651
M109A	Highly altered Bullion Canyon Volcanics lava flow (Tb), collected near Deer Flat.	38°30'20" N.	112°17'18" W.	0.061	2.312
M109B	Moderately altered Bullion Canyon Volcanics lava flow (Tb), collected near Deer Flat.	38°30'20" N.	112°17'18" W.	0.037	2.336
M109C	Slightly altered Bullion Canyon Volcanics lava flow (Tb), collected near Deer Flat.	38°30'20" N.	112°17'18" W.	0.084	2.321
M109D	Fresh Bullion Canyon Volcanics lava flow (Tb), collected near Deer Flat.	38°30'20" N.	112°17'18" W.	0.11	2.398
M145A	Slightly altered, light yellow, middle tuff member (Tmm), collected on Signal Peak in the Mount Belknap caldera.	38°27'42" N.	112°23'58" W.	0.087	2.256
M145B	Densely welded, hard, red, middle tuff member (Tmm), collected on Signal Peak in the Mount Belknap caldera.	38°27'42" N.	112°23'58" W.	0.501	2.353
M177	Fresh quartz monzonite (Tbi), collected from Tip Top near the headwaters of Fish Creek.	38°29'19" N.	112°25'14" W.	3.42	2.707

Table 1.—Magnetic susceptibility, dry bulk density, location, and description of igneous rock samples from the Marysvale volcanic field, Utah—Continued

Sample No.	Rock Unit	Latitude	Longitude	Magnetic Susceptibility, in e.m.u./cm^3 (All values x10^{-3})	ρ_b Dry bulk Density, in g/cm^3
M194	Highly altered middle tuff member of the Mount Belknap Volcanics (Tmm), collected near the drill site along the road through the Mount Belknap caldera.	38°23'49" N.	112°24'09" W.	0.12	1.981
M206	Fresh Mount Baldy Rhyolite Member of the Mount Belknap Volcanics (Tmb), collected at the North Fork of North Creek in the Mount Belknap caldera.	38°23'53" N.	112°29'24" W.	0.70	2.530
M220	Fresh, massive Mount Baldy Rhyolite Member of the Mount Belknap Volcanics (Tmb), collected on Mount Baldy in the Mount Belknap caldera.	38°24'11" N.	112°25'50" W.	0.22	2.470
M223	Moderately altered Mount Baldy Rhyolite Member of the Mount Belknap Volcanics (Tmb), collected on ridge going north from Mount Baldy, near the center of the Mount Belknap caldera.	38°26'22" N.	112°27'03" W.	0.71	2.223
M225	Slightly altered, steamed white Mount Baldy Rhyolite Member of the Mount Belknap Volcanics (Tmb), collected near Indian Creek, in the Mount Belknap caldera.	38°25'16" N.	112°29'08" W.	0.10	2.323
M238	Highly altered, zeolitic Red Hills Tuff Member of the Mount Belknap Volcanics (Tmr), collected northwest of Marysvale near the Beaver Creek stock.	38°27'58" N.	112°14'44" W.	0.050	1.652
M251	Fresh rhyolite intrusive rock (Tmic), collected from the North Fork of North Creek stock in the Mount Belknap caldera.	38°23'56" N.	112°27'09" W.	0.21	2.414
M261	Fresh middle Bullion Canyon Volcanics lava flow (Tbm), collected near the head of Bullion Canyon.	38°23'51" N.	112°23'25" W.	0.12	2.534
M263	Propylitized upper Bullion Canyon Volcanics lava flow (Tbu), collected near Delano Peak.	38°22'52" N.	112°23'29" W.	0.46	2.501
M330	Fresh, dense, dark-colored rhyolite intrusive containing up to 2 cm long K-feldspar crystals (Timc), collected underground at the U-Beva prospect.	38°22'58" N.	112°31'12" W.	3.29	2.640
M468	Propylitized Mount Dutton Formation pyroxene-hornblende lava flow (Td), collected on the north side of the entrance to Oak Springs Canyon.	38°18'12" N.	112°13'48" W.	1.55	2.627
M470	Slightly oxidized Mount Dutton Formation basaltic andesite lava flow (Td), collected from the top of the highest hill south of the entrance to Oak Springs Canyon.	38°18'02" N.	112°14'02" W.	2.24	2.795
M472	Fresh, devitrified Osiris Tuff (To), collected on the crest of the ridge between Big Flat and City Creek peak.	38°18'22" N.	112°20'50" W.	0.58	2.313
M489	Moderately welded, crystal-rich tuff member of the Mount Belknap Volcanics (Tmc), collected near Three Creeks reservoir.	38°18'17" N.	112°24'36" W.	0.31	1.500
M504	Moderately welded tuff of Lion's Flat (Ttl), collected from switchback above the powerhouse on Utah Highway 153.	38°16'12" N.	112°29'12" W.	0.33	1.684
M505	Fresh, porphyritic formation of Louey Jim (Sigmund, 1979) lava flow (Tlj), collected at vent area along Utah Highway 153.	38°16'45" N.	112°27'31" W.	0.43	2.408

Table 1.—Magnetic susceptibility, dry bulk density, location, and description of igneous rock samples from the Marysvale volcanic field, Utah—Continued

Sample No.	Rock Unit	Latitude	Longitude	Magnetic Susceptibility, in e.m.u./cm^3 (All values $x10^{-3}$)	ρ_b Dry bulk Density, in g/cm^3
M519	Fresh volcanic rocks of Little Table, vent facies (Tltv), collected south of the Central Mining Area.	38°27'08" N.	112°11'55" W.	2.66	2.615
M520	Fresh, pyroxene-plagioclase Bullion Canyon Volcanics lava flow (Tb), collected south of the Central Mining Area.	38°27'04" N.	112°12'27" W.	1.28	2.580
M522	Fresh quartz monzonite of the Bullion Canyon Volcanics (Tbi), collected south of the Central Mining Area near the Dark Horse Mine.	38°28'17" N.	112°13'04" W.	2.08	2.578
M549	Devitrified, crystal-rich rhyolite intrusive (Tmi), collected from the Four Horsemen dome.	38°29'52" N.	112°10'37" W.	0.40	2.291
M563	Altered, intermediate composition Bullion Canyon Volcanics lava flow (Tb), collected near the Central Mining Area.	38°28'21" N.	112°26'03" W.	0.045	1.956
M569	Fresh monzonite of the intrusions related to the Monroe Peak caldera (Tim), coarse-grained facies, collected from Dry Canyon, in the Monroe Peak caldera.	38°31'58" N.	112°07'35" W.	1.88	2.558
M575	Slightly altered, bleached, iron-stained Blue Lake Rhyolite Member of the Mount Belknap Volcanics (Tmbl), collected near the Pipeline Trail on Gold Mountain, in the Mount Belknap caldera.	38°26'17" N.	112°23'55" W.	0.062	2.488
M581	Fresh Mount Baldy Rhyolite Member of the Mount Belknap Volcanics fine-grained lava flow (Tmb), collected from the summit of Mount Belknap in the Mount Belknap caldera.	38°25'10" N.	112°24'40" W.	0.44	2.492
M582	Moderately fresh middle tuff member of the Mount Belknap Volcanics (Tmm), collected under the summit of Mount Belknap in the Mount Belknap caldera.	38°25'10" N.	112°24'27" W.	0.33	2.306
M583	Moderately fresh Blue Lake Rhyolite Member of the Mount Belknap Volcanics lava flow (Tmbl), collected west of Mount Belknap in the Mount Belknap caldera.	38°24'50" N.	112°23'45" W.	0.094	2.327
M584	Moderately fresh Mount Baldy Rhyolite Member of the Mount Belknap Volcanics lava flow (Tmb), collected west of Mount Belknap in the Mount Belknap caldera.	38°24'03" N.	112°24'12" W.	0.066	2.325
M586	Highly altered middle tuff member of the Mount Belknap Volcanics (Tmm), collected near the drill site along the road through the Mount Belknap caldera.	38°23'50" N.	112°24'12" W.	0.091	2.004
M608	Fresh quartz monzonite of the Bullion Canyon Volcanics (Tbi), collected from the stock under the power line southeast of the Central Intrusive.	38°29'05" N.	112°10'40" W.	1.41	2.518
M621	Fresh quartz monzonite of the Bullion Canyon Volcanics (Tbi), collected from the west side of Flat Top in the Central Intrusive.	38°30'23" N.	112°11'55" W.	6.11	2.731
M657	Fresh, potassium-rich mafic lava flows (Tpml), collected from Big Flat.	38°16'16" N.	112°22'04" W.	2.63	2.621
M678	Fresh, sanidine-bearing dacitic lava flows (Tsd), collected above Hunt's lake on Monroe Mountain.	38°32'52" N.	112°05'04" W.	0.22	2.280

Table 1.—Magnetic susceptibility, dry bulk density, location, and description of igneous rock samples from the Marysvale volcanic field, Utah—Continued

Sample No.	Rock Unit	Latitude	Longitude	Magnetic Susceptibility, in e.m.u./cm^3 (All values x10^{-3})	ρ_b Dry Bulk Density, in g/cm^3
M713A	Highly altered Bullion Canyon Volcanics lava flow (Tb), collected west of the La Veta Mine.	38°31'22" N.	112°11'16" W.	0.078	1.763
M713B	Highly altered Bullion Canyon Volcanics lava flow (Tb), collected west of the La Veta Mine.	38°31'22" N.	112°11'16" W.	0.10	1.617
M739	Fresh mafic tuff of Albinus Canyon (Ta), collected from the type area near Albinus Canyon in the Pavant Range.	38°41'17" N.	112°11'09" W.	1.72	2.600
M755	Fresh monzonite of the intrusions related to the Monroe Peak caldera (Tim), fine-grained facies, collected from the west side of the Sevier Plateau, north of Dry Canyon, in the Monroe Peak caldera.	38°32'34" N.	112°07'51" W.	0.13	2.499
M798	Fresh, potassium-rich mafic lava flow (Tpml), collected northeast of Junction, near the Piute Reservoir.	38°15'12" N.	112°12'43" W.	1.55	2.642
M800	Fresh basalt (Tbas), collected from the ridge east of Piute Reservoir.	38°18'50" N.	112°09'22" W.	2.61	2.597
M801	Fresh basalt (Tbas), collected from hill north of City Creek.	38°15'48" N.	112°17'16" W.	1.58	2.655
M809	Poorly welded Joe Lott Tuff Member of the Mount Belknap Volcanics (Tmj), collected from the distal end of the ash sheet, near Monroe.	38°34'18" N.	112°08'10" W.	0.40	1.795
M824	Fresh, potassium-rich mafic lava flow (Tpml), collected on Black Ridge, east of Beaver.	38°18'08" N.	112°33'24" W.	2.07	2.788
M851	Fresh quartz monzonite intrusive of the Bullion Canyon Volcanics (Tbi), collected from the Central Intrusive just west of the Royal Purple Mine.	38°30'43" N.	112°13'05" W.	3.33	2.736
M859	Densely welded, red, middle tuff member of the Mount Belknap Volcanics (Tmm), collected from the Hogback in the Mount Belknap caldera.	38°29'05" N.	112°27'05" W.	0.89	2.332
M864	Slightly altered, pyrite-bearing Blue Lake Rhyolite Member of the Mount Belknap Volcanics lava flow (Tmbl), collected from altered area east of Blue Lake.	38°24'37" N.	112°24'53" W.	0.034	2.412
M867	Fresh quartz monzonite intrusive of the Bullion Canyon Volcanics (Tbi), collected from the Central Intrusive at the north end of the Central Mining Area.	38°30'19" N.	112°12'52" W.	3.61	2.732
M873	Highly altered, alunitized Bullion Canyon Volcanics lava flow (Tb), collected from the upper pit of the Whitehorse Mine.	38°28'24" N.	112°11'23" W.	0.067	2.162
M874	Highly altered, kaolinitized Joe Lott Tuff Member of the Mount Belknap Volcanics (Tmj), collected from the Mill Creek kaolinite pit.	38°31'14" N.	112°23'21" W.	0.017	2.032
M881	Highly altered, white, alunitized Bullion Canyon Volcanics lava flow (Tb), collected from the south end of Big Rock Candy Mountain.	38°30'20" N.	112°15'41" W.	0.057	1.910
M883	Moderately altered, pyrite-bearing Bullion Canyon Volcanics lava flow (Tb), collected from Big Rock Candy Mountain.	38°30'38" N.	112°15'43" W.	0.028	2.387

Table 1.—Magnetic susceptibility, dry bulk density, location, and description of igneous rock samples from the Marysvale volcanic field, Utah—Continued

Sample No.	Rock Unit	Latitude	Longitude	Magnetic Susceptibility, in e.m.u./cm^3 (All values x10^{-3})	ρ_b Dry bulk Density, in g/cm^3
M885	Highly altered, yellow Bullion Canyon Volcanics lava flow (Tb), collected from in back of the Big Rock Candy resort.	38°30'52" N.	112°15'56" W.	0.082	2.232
M902	Fresh Delano Peak Tuff Member of the Bullion Canyon Volcanics (Tbd), collected near the summit of the Tushar Mountains, north of Delano Peak.	38°23'22" N.	112°23'50" W.	0.25	2.323
M903	Fresh upper Bullion Canyon Volcanics mafic lava flow (Tbu), collected in the Big John caldera.	38°23'09" N.	112°23'50" W.	1.04	2.591
M905	Fresh upper Bullion Canyon Volcanics mafic lava flow (Tbu), collected from the same flow that makes up Delano Peak.	38°22'05" N.	112°23'27" W.	0.66	2.531
M907	Fresh, densely welded Three Creeks Tuff Member of the Bullion Canyon Volcanics (Tbt), collected from the Narrows along Utah Highway 4.	38°34'51" N.	112°07'36" W.	0.90	2.533
M908	Fresh, moderately welded Three Creeks Tuff Member of the Bullion Canyon Volcanics (Tbt), collected from the Narrows along Utah Highway 4.	38°34'52" N.	112°07'45" W.	0.37	2.386
M910	Fresh basaltic andesite lava flow (Tan), collected along the Rockwood Station road in the Pavant Range.	38°38'26" N.	112°16'12" W.	1.71	2.447
M912	Fresh, densely welded Needles Range Formation ash-flow tuff (Tn), collected near the Joseph Hot Spring.	38°37'31" N.	112°11'35" W.	0.28	2.191
M913	Fresh, densely welded tuff of Albinus Canyon (Ta), collected near the Joseph Hot Spring.	38°37'30" N.	112°11'25" W.	0.47	1.975
M914	Fresh, medium-grained monzonite intrusive of the intrusions related to the Monroe Peak caldera (Tim), collected from Flat Canyon on the west side of the Sevier Plateau.	38°29'02" N.	112°07'30" W.	0.61	2.487
M915	Fresh, medium-grained monzonite intrusive of the intrusions related to the Monroe Peak caldera (Tim), collected from Smith Canyon on the west side of the Sevier Plateau.	38°27'31" N.	112°06'33" W.	1.02	2.520
M928	Moderately welded tuff of Lions Flat (Ttl), collected on ridge south of South Fork of North Creek, probably in the source area.	38°19'34" N.	112°32'00" W.	0.23	1.849
M929	Propylitized Bullion Canyon Volcanics mafic pyroxene-plagioclase lava flow (Tb), collected along Pine Creek in the Western Tushar Mountains.	38°30'07" N.	112°33'07" W.	1.14	2.349
M930A	Fresh, porphyritic monzonite intrusion of the Bullion Canyon Volcanics (Tbi), collected along Pine Creek in the Western Tushar Mountains.	38°29'48" N.	112°32'50" W.	0.48	2.303
M930D	Fresh, porphyritic monzonite intrusion of the Bullion Canyon Volcanics (Tbi), collected along Pine Creek in the Western Tushar Mountains.	38°29'48" N.	112°32'50" W.	0.69	2.466
75-S-20	Propylitized Three Creeks Tuff Member of the Bullion Canyon Volcanics (Tbt), collected on the south side of Bullion Canyon, 1.84 km northeast of Mount Brigham.	38°23'23" N.	112°20'00" W.	0.099	2.587

Table 1.—Magnetic susceptibility, dry bulk density, location, and description of igneous rock samples from the Marysvale volcanic field, Utah—Continued

Sample No.	Rock Unit	Latitude	Longitude	Magnetic Susceptibility, in e.m.u./cm^3 (All values $x10^{-3}$)	ρ_b Dry bulk Density, in g/cm^3
79-S-44B	Fresh, slightly vesicular, basaltic andesite of Cove Fort, lava flow (Qcf), collected about eight miles west of Cove Fort on the western flank of the Cove Fort shield volcano.	38°35'23" N.	112°43'35" W.	0.96	2.602
78-698	Fresh Mount Dutton Formation flow breccia, alluvial faciee (Td), collected east of Piute Reservoir, central Sevier Plateau.	38°16'12" N.	112°10'30" W.	4.71	2.594
79-1517	Fresh volcanics of Langdon Mountain lava flow, vent facies (Tlmv), collected from the central Sevier Plateau.	38°23'50" N.	112°01'50" W.	2.92	2.709
79-1518	Fresh volcanics of Little Table lava flow, vent facies. More mafic than the Langdon Mountain.	38°22'20" N.	112°04'58" W.	2.43	2.606
79-1666	Fresh Bullion Canyon Volcanics lava flow, vent facies (Tb), collected in Monroe Canyon, southeast of Monroe, in the northern Sevier Plateau.	38°35'57" N.	112°05'05" W.	3.19	2.647

DESCRIPTION OF ROCK UNITS IN MARYSVALE VOLCANIC FIELD

Qcf BASALTIC ANDESITE OF COVE FORT (PLEISTOCENE)--Dark-gray to black, vesicular to dense lava flows containing phenocrysts and microphenocrysts of plagioclase, pyroxene, magnetite, olivine, and sparse corroded quartz in a felted matrix of microlites and glass

Tbas BASALT LAVA FLOWS (MIOCENE)--Black to dark-gray, vesicular or amygdaloidal olivine basalt. Includes some scoria

MOUNT BELKNAP VOLCANICS (MIOCENE)

Tmic Intracaldera intrusive rocks--Several small porphyritic quartz latitic to rhyolitic stocks within the Mount Belknap caldera. Contain sparse phenocrysts of quartz, plagioclase, and sanidine in a finely granular mosaic of alkali feldspar and quartz

Tmf Fine-grained granite--Forms a small stock and related dikes that host the uranium-bearing veins in the Central Mining Area 6 km north of Marysvale. Contains phenocrysts of quartz, orthoclase, plagioclase, and minor biotite in a groundmass characterized by graphic intergrowths

Tmi Porphyritic rhyolitic stocks and volcanic domes--Several small bodies 8 km northeast of Marysvale. Contain phenocrysts of sanidine, plagioclase, biotite, hornblende, quartz, and minor apatite, sphene, and magnetite in a devitrified or glassy matrix

Tmg Gray Hills Rhyolite Member--Light-gray, spherulitically devitrified rhyolite lava flows. Contains sparse sanidine phenocrysts and is characterized by contorted flow layers

Tmc Crystal-rich member--Dark-reddish-brown, moderately welded, alkali rhyolite ash-flow tuff containing 30 percent phenocrysts of anorthoclase, quartz, sodic plagioclase, and biotite. Derived from the Mount Belknap caldera source area

Tmr Red Hills Tuff Member--Reddish-brown, crystal-poor, densely welded, alkali rhyolite ash-flow tuff. Contains about 7 percent phenocrysts of anorthoclase, quartz, plagioclase, and minor biotite. Derived from the Red Hills caldera source area

Tmj Joe Lott Tuff Member--Partially welded, crystal-poor, light-gray or tan, alkali rhyolite ash-flow tuff containing 1-2 percent phenocrysts of quartz, sodic plagioclase, sanidine, and traces of biotite. Comprises most of the outflow facies derived from the Mount Belknap caldera source area

Intracaldera facies volcanic rocks (Mount Belknap caldera)

Tmb Mount Baldy Rhyolite Member--Light-gray, crystal-poor, rhyolite lava flows and dikes consisting largely of a fine granular mosaic of quartz and alkali feldspar, and minor plagioclase, biotite, and hematite. Contorted flow layers are common. Mostly intracaldera facies, but locally extends out across the margin of the Mount Belknap caldera

Tmm Middle tuff member--Light-gray to buff, partially welded, crystal-poor, rhyolite ash-flow tuff. Lithologically similar to, and locally continuous across the caldera margin into, the upper part of the Joe Lott Tuff Member (Tmj)

Tmbl Blue Lake Rhyolite Member--Crystal-poor, rhyolite lava flows lithologically similar to those in the Mount Baldy Rhyolite Member (Tmb). Contorted flow layers are characteristic

Tpml POTASSIUM-RICH MAFIC LAVA FLOWS (MIOCENE)--Black to dark-gray, vesicular mafic lava flows containing olivine, augite, plagioclase laths, and Fe-Ti oxides. Includes some scoria and amygdaloidal flows

Tlj FORMATION OF LOUSY JIM (SIGMUND, 1979) (MIOCENE)--Light- to dark-gray, quartz latitic porphyry lava flows and flow breccia. Contains 23 percent phenocrysts of plagioclase, amphibole, clinopyroxene, magnetite, biotite, quartz, and accessory minerals in a glassy groundmass

Ttl TUFF OF LION FLAT (MIOCENE)--Light-gray to grayish-pink, ash-flow tuff consisting of glass shards, pumice fragments, and volcanic dust, and about 5 to 15 percent phenocrysts of plagioclase, quartz, sanidine, biotite, and amphibole. Locally reworked and zeolitized

Tsd SANIDINE-BEARING DACITIC LAVA FLOWS (MIOCENE)--Resistant to moderately resistant, generally light to dark gray and dark brown, locally vesicular or amygdaloidal, locally flow layered, dacitic lava flows. Locally includes volcanic mudflow breccia and ash-flow tuff. Contains moderately abundant phenocrysts of plagioclase, sanidine, pyroxene, and biotite, and minor Fe-Ti oxides and olivine; sanidine phenocrysts may be as long as 2 cm. Considered to be the extrusive equivalent of the resurgent intrusive rocks (Tim) that invaded the volcanic rocks filling the Monroe Peak caldera

Tim INTRUSIONS RELATED TO THE MONROE PEAK CALDERA (MIOCENE)--Generally resistant, light-gray and grayish-green, monzonite porphyry and subordinate quartz monzonite porphyry. Constitutes the main resurgent phase of the intrusions related to the Monroe Peak caldera. Contains large phenocrysts of plagioclase and orthoclase, with smaller pyroxene and biotite, in a groundmass dominated by orthoclase, Fe-Ti oxides, and quartz. A fine-grained more potassic phase is present near the upper parts of most of the intrusion

To OSIRIS TUFF (MIOCENE)--Gray and reddish-brown, densely welded, crystal-rich ash-flow tuff. Phenocrysts consist of andesine and subordinate sanidine, pyroxene, and minor biotite, and Fe-Ti oxides

BULLION CANYON VOLCANICS (MIOCENE AND OLIGOCENE)

Tbi Intermediate-composition intrusive rock (Miocene)--Dark- to light-gray and brown, strongly porphyritic quartz latite and latite and porphyritic to equigranular, fine- to medium-grained quartz monzonite, monzonite, and granodiorite. The more crystalline rocks commonly contain approximately equal proportions of plagioclase and orthoclase, 0-20 percent quartz, plus augite, hornblende, and biotite. Accessory minerals are apatite, zircon, and Fe-Ti oxides

Tbu Upper member (Miocene)--Mostly dark gray to black, fine-grained rhyodacite to andesite lava flows and local densely welded ash-flow tuff, some of which show prominent lineate texture due to secondary flowage. Overlies Delano Peak Tuff Member in central Tushar Mountains

Tbd Delano Peak Tuff Member (Miocene)--Dark-reddish-brown, densely welded, crystal-rich quartz latite ash-flow tuff containing 40-50 percent phenocrysts of andesine, hornblende, biotite, and minor quartz, zircon, and apatite. Source area marked by Big John caldera in central Tushar Mountains

Tbm Middle member (Miocene and Oligocene)--Mostly light gray and brown rhyodacite lava flows, flow breccia, and volcanic mudflow breccia that lie between the overlying Delano Peak Tuff Member (Tbd) and underlying Three Creeks Tuff Member (Tbt) in the central Tushar Mountains

Tbt Three Creeks Tuff Member (Oligocene)--Light-gray and brown, densely welded, crystal-rich quartz latite ash-flow tuff containing 45-50 percent phenocrysts of plagioclase, hornblende, biotite, and quartz, with trace amounts of Fe-Ti oxide minerals, sanidine, and other accessory minerals

Tb Heterogeneous lava flows and volcanic breccia (Miocene and Oligocene)--Porphyritic andesite, rhyodacite, and quartz latite. Contains phenocrysts of plagioclase, biotite, and clinopyroxene. In part consists of fine-grained dark lava flows and breccia of intermediate composition, containing small phenocrysts of plagioclase and clinopyroxene

Ta TUFF OF ALBINUS CANYON (MIOCENE OR OLIGOCENE)--Red to gray, vesicular, densely welded ash-flow tuff (tufflava) containing a few percent phenocrysts of calcic andesite-labradorite, augite, and biotite in a glassy to devitrified matrix. Prominent fluidal textures from secondary flow and very abundant lineate vesicles are characteristic

Tan BASALTIC ANDESITE (MIOCENE OR OLIGOCENE)--Vesicular, black to dark-gray lava flows containing phenocrysts of calcic labradorite, pyroxene, magnetite, and olivine (altered to iddingsite) in a glassy to microgranular matrix

Tlmv VENT FACIES VOLCANIC ROCKS OF LANGDON MOUNTAIN (MIOCENE)--Resistant, pink, tan, light-gray, purplish-gray, locally amygdaloidal lava flows of dacitic composition that overlie and are interbedded with the upper part of both the Mount Dutton Formation (Td) and the volcanic rocks of Little Table. The rocks are part of a stratovolcano centered at or near Langdon Mountain. Contain phenocrysts of hornblende, subordinate plagioclase and pyroxene, and minor Fe-Ti oxides

Tltv VENT FACIES VOLCANIC ROCKS OF LITTLE TABLE (MIOCENE AND OLIGOCENE)--Resistant, tan, khaki, dark-gray to dark-brown lava flows, tuff lava, flow breccia, and volcanic mudflow breccia that are interbedded with, pinch out southward against, and locally underlie the Mount Dutton Formation and are interbedded with and underlie the lower parts of the volcanic rocks of Langdon Mountain. Contains phenocrysts of plagioclase and generally subordinate pyroxene and Fe-Ti oxides and minor olivine

Td MOUNT DUTTON FORMATION (MIOCENE AND OLIGOCENE)--Soft to moderately resistant, tan, pink, light-gray, or less commonly pale-green or light-purple, volcanic mudflow breccia and sparse flow breccia, lava flows, local ash-flow tuff, and fluviatile conglomerate and sandstone. Flow rock and clasts in the breccia are characterized by several lithologies that are dacitic to andesitic in composition and have few phenocrysts; many rocks are aphanitic. Phenocrysts consist largely of plagioclase and either hornblende or pyroxene and minor Fe-Ti oxides

Tn NEEDLES RANGE FORMATION (OLIGOCENE)--Gray, tan, or pink, moderately welded quartz latite ash-flow tuff consisting of 40-50 percent phenocrysts of andesine, hornblende (10-15 percent), biotite, and minor sanidine, quartz, pyroxene, and Fe-Ti oxides. The high hornblende-to-biotite ratio is a distinguishing characteristic

Table 2.--Average dry bulk densities, standard deviation, and number of samples for igneous rocks from the Marysvale volcanic field, Utah

[Some rocks have been used in more than one category where appropriate]

	Mean Density in g/cm^3	Standard Deviation	Number of Samples
Intrusive Rocks			
Rhyolite intrusives	2.416	0.158	4
Granites	2.520	--	1
Monzonites	2.586	0.131	14
Mount Belknap Volcanics			
Highly altered	1.917	0.178	4
Moderately altered	2.223	--	1
Slightly altered	2.408	0.083	3
Fresh	2.298	0.243	9
Bullion Canyon Volcanics			
Highly altered	2.077	0.137	8
Moderately altered	2.261	0.205	4
Slightly altered	2.321	--	1
Fresh	2.537	0.137	16
Extrusive Rocks			
Poorly welded tuffs	1.795	--	1
Moderately welded tuffs	1.890	0.338	6
Densely welded tuffs	2.277	0.208	5
Basalts	2.619	0.125	5
Rhyolites	2.391	0.101	10

(Samples M88, M91, M94, M206, M220, M223, M225, M522, M575, M581, M583, M584, M608, M621, M851, M864, M867, M907, M908, M930A, M930D were used in more than one category where appropriate.)

Table 3.--Average magnetic susceptibilities, value range, and number of samples for igneous rocks from the Marysvale volcanic field, Utah

[Some rocks have been used in more than one category where appropriate. The reported average values represent the antilog of the mean of the natural logarithms of measured magnetic susceptibility values thus assuming a log normal distribution]

	Average Magnetic Susceptibility in e.m.u./cm^3 (All values $x10^{-3}$)	Value Range (All values $x10^{-3}$)	Number of Samples
Intrusive Rocks			
Rhyolite intrusives	0.71	0.49-1.63	4
Granites	0.90	--	1
Monzonites	1.52	0.54-4.32	14
Mount Belknap Volcanics			
Highly altered	0.055	0.023-0.13	4
Moderately altered	0.71	--	1
Slightly altered	0.060	0.035-0.10	3
Fresh	0.22	0.093-0.54	9
Bullion Canyon Volcanics			
Highly altered	0.065	0.050-0.086	8
Moderately altered	0.043	0.029-0.066	4
Slightly altered	0.087	--	1
Fresh	0.91	0.28-3.01	16
Extrusive Rocks			
Poorly welded tuffs	0.40	--	1
Moderately welded tuffs	0.23	0.13-0.41	6
Densely welded tuffs	0.56	0.34-0.91	5
Basalts	1.72	1.17-2.53	5
Rhyolites	0.18	0.058-0.56	10

frames. The rock sample, maximum dimensions of 4" (10.16 cm), is inserted in one coil while the other remains empty, and the bridge is rebalanced. Calibration of the bridge is done using samples of known susceptibility (Rosenbaum and others, 1979).

Discussion of results

Figure 1 is a composite histogram of the measured dry bulk densities of all 88 samples of igneous rocks from the Marysvale volcanic field, and figure 2 is a composite histogram of the measured magnetic susceptibilities of the same rocks. Checking the numerical values in tables 1, 2, and 3 against the petrological descriptions shows that rocks with low dry bulk densities and low magnetic susceptibilities are either ash-flow tuffs of the Mount Belknap Volcanics or highly altered rocks of the Bullion Canyon Volcanics.

The dry bulk density and magnetic susceptibility of rocks from both the Mount Belknap Volcanics and the Bullion Canyon Volcanics vary systematically as a function of the intensity of alteration as shown in figures 3, 4, 5, and 6 and tables 1 and 2. In general, both the dry bulk density and the magnetic susceptibility decrease as the intensity of alteration increases. As alteration progresses from fresh through propylitic, argillic, and to advanced argillic, mineralogic changes occur that are not isochemical. Magnetite accounts for a major part of a rock's magnetic properties, and as the degree of alteration increases, the magnetite becomes oxidized to hematite or hydrated to limonite. The bulk density of a rock typically decreases as the degree of hydrothermal alteration increases, mostly because there is a concurrent increase in pore space. Notable exceptions to systematic trends in dry bulk density occur where fresh rocks include low-density samples (such as M91 and M94) that are poor-to-moderately welded ash-flow tuffs containing visible pumice fragments, or high-density samples of highly altered rocks (such as M53) that contain a dense intergrowth of alunite (density about 2.7 g/cm^3) and quartz. Comparison of the above figures and tables shows that these trends are the same for both the Mount Belknap Volcanics and the Bullion Canyon Volcanics but are offset to values of higher dry bulk densities and magnetic susceptibilities in the Bullion Canyon Volcanics as would be expected with the overall increase in ferromagnesium content of the latter. The large range in magnetic susceptibility and dry bulk density of fresh Bullion Canyon Volcanics may result from incipient alteration of magnetite.

Dry bulk densities and magnetic susceptibilities of the intrusive rocks are shown in figures 7 and 8, respectively. The monzonites have slightly higher densities and magnetic susceptibilities than the granites and rhyolite intrusives corresponding to their higher ferromagnesium content.

Dry bulk densities and magnetic susceptibilities of the extrusive rocks are shown in figures 9 and 10, respectively. These figures show that there is a large, systematic increase in the dry bulk density of welded tuffs as the degree of welding increases. The rhyolite lava flows have about the same dry bulk densities as the most densely welded tuffs and the basalts have the greatest dry bulk densities of all. The magnetic susceptibilities of the welded tuffs and rhyolite lava flows are generally similar to each other and vary more as a function of the intensity of alteration. The basalts have the highest magnetic susceptibilities of the 88 measured rocks.

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