Stanford Canyon Quadrangle, Cochise County, Arizona— Analytic Data and Geologic Sample Catalog

U.S. GEOLOGICAL SURVEY BULLETIN 2021–D

Chapter D

Stanford Canyon Quadrangle, Cochise County, Arizona— Analytic Data and Geologic Sample Catalog

By EDWARD A. DU BRAY and JOHN S. PALLISTER

Geochemical data for and availability of samples collected during geologic mapping of the quadrangle

U.S. GEOLOGICAL SURVEY BULLETIN 2021

GEOLOGIC SAMPLING OF THE CHIRICAHUA MOUNTAINS, ARIZONA

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PLATE

[Plate is in pocket]

FIGURE

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Stanford Canyon Quadrangle, Cochise County, Arizona—Analytic Data and Geologic Sample Catalog

By Edward A. du Bray *and* John S. Pallister

Abstract

About 120 rock samples were collected during geologic mapping of the Stanford Canyon 7½-minute quadrangle in southeastern Arizona. Energy-dispersive trace-element analyses were conducted for 90 samples, major-oxide abundances were determined for 38 samples, and instrumental neutron activation analyses were conducted for four samples. Miscellaneous wet chemical determinations (CO_2, FeO, F, and Cl) were made for three samples. Standard, and in some cases polished, thin sections were prepared for about half of the samples. All of these resources aided map-unit characterization. The availability of chemical data, thin sections, and hand specimens for each of the samples collected in the quadrangle is tabulated in this report. Information in this report supplements the geologic map of the Stanford Canyon quadrangle (U.S. Geological Survey Geologic Quadrangle Map GQ–1743) and supports ongoing investigations of the Turkey Creek caldera.

INTRODUCTION

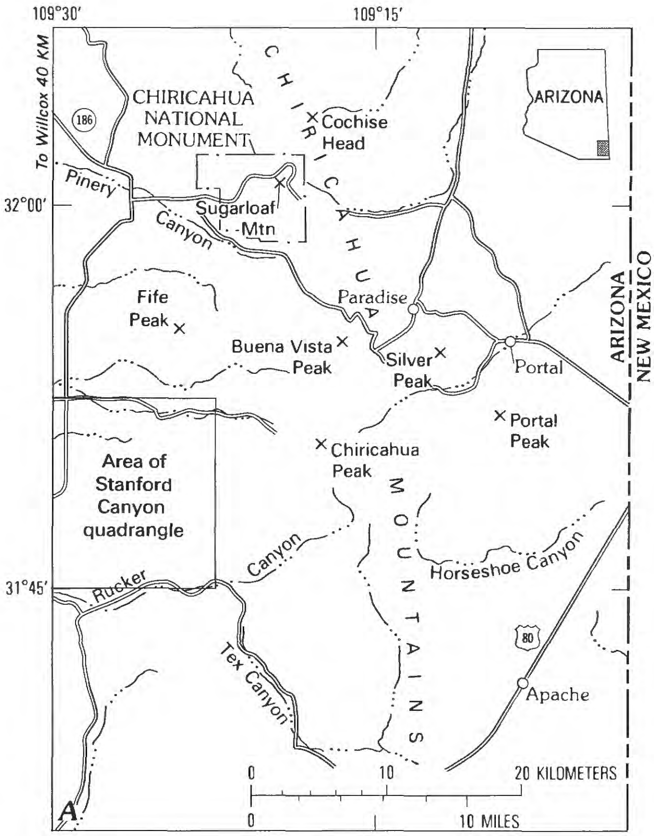
The Stanford Canyon 7½-minute quadrangle (fig. 1) is east-southeast of Tucson, Ariz., in the Chiricahua Mountains. The quadrangle is located about 70 km southeast of Willcox, Ariz. The Stanford Canyon quadrangle includes the western range front of the Chiricahua Mountains and offers unusual ecologic diversity that ranges from Sonoran desert through subalpine environments. Altitudes range from about 1,495 m (4,900 ft) on the pediment surface in the west part of the quadrangle (pl. 1) to 2,450 m (8,040 ft) at Stanford Peak. No paved roads are present within the quadrangle. Well-maintained though unpaved roads along Turkey Creek, Rucker Canyon, and along the west edge of the quadrangle, a set of rough unpaved roads that traverse the center of the area, and a few trails provide reasonably good access to most of the area.

This report supplements the geologic map of the Stanford Canyon quadrangle (du Bray and Pallister, in press b). It lists the availability of chemical data, thin sections, and hand specimens for each of the samples collected in the quadrangle (table 1) and provides tabulations of chemical data (tables 2-5) for samples of Tertiary volcanic rocks that were collected during geologic mapping of the quadrangle. The mapping and data collection are both part of a continuing volcanologic study of the Chiricahua Mountains in general and of the Turkey Creek caldera in particular. The geology of the area has been summarized by Pallister and du Bray (1989) and by Pallister and others (1990). The data presented here have contributed to a study concerning evolution of the Turkey Creek caldera (du Bray and Pallister, 1991) and ongoing topical studies.

GENERAL GEOLOGY

Erosion and basin-range faulting in the Chiricahua Mountains have exposed multiple levels through the 27-Ma (Pallister and du Bray, 1989) Turkey Creek caldera. Parts of the 20-km-diameter caldera underlie the eastern half of the Stanford Canyon quadrangle. Components of the caldera exposed in the quadrangle are all of Oligocene age and include, from oldest to youngest, intracaldera and outflow facies of the Rhyolite Canyon Tuff; dacite porphyry, which forms a resurgent core intrusion and a ring intrusion with associated lava flows; and minor rhyolite tuff that fills the caldera moat. Stratigraphic, structural, and geochronologic data indicate that the porphyry was emplaced soon after the Rhyolite Canyon Tuff erupted and that the evolution of the caldera, including deposition of the moat deposits, was completed in less than 1 million years.

In the Stanford Canyon quadrangle (du Bray and Pallister, in press b), the caldera system is surrounded by, and was partly emplaced into, slightly older Tertiary volcanic rocks. Outflow tuff from the Turkey Creek caldera was deposited on middle Tertiary volcanic (and minor volcaniclastic) rocks, including rhyolite ash-flow tuffs and underlying andesitic to basaltic flow rocks (du Bray and Pallister, in press b).



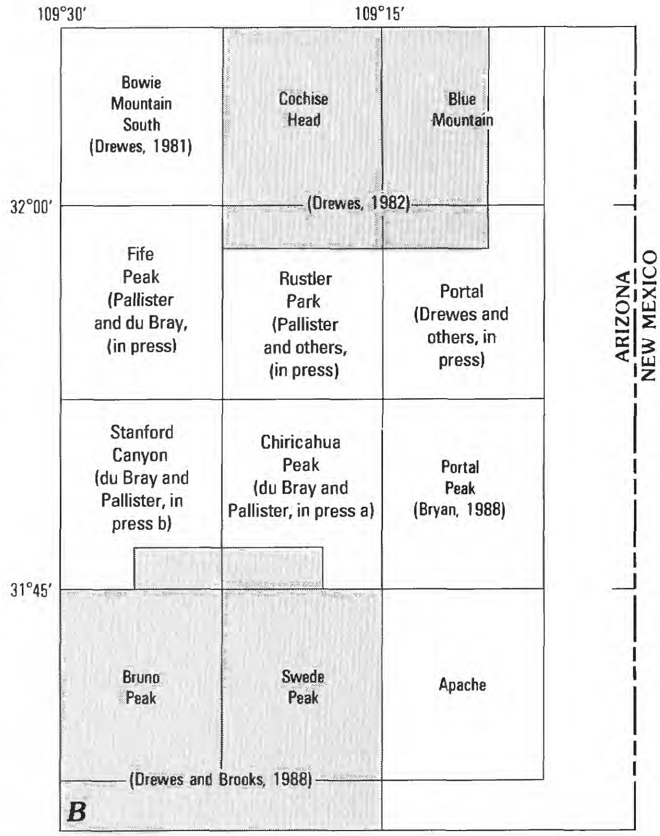


Figure 1. Location of the Stanford Canyon quadrangle and important geographic and geologic features in the Chiricahua Mountains area, Cochise County, Arizona.

A, Quadrangle location, roads, and important geographic features.

B, U.S. Geological Survey quadrangle names in the area and existing geological maps (cited in parentheses).

C, (on facing page) Generalized geology (adapted from Marjaniemi, 1969).

EXPLANATION FOR GEOLOGIC MAP ON FACING PAGE

Quaternary surficial deposits

OLIGOCENE ROCKS ASSOCIATED WITH THE TURKEY CREEK CALDERA

Moat deposits—Mainly rhyolite lavas and pyroclastic rocks

Resurgent intrusion, ring dike, and extrusive equivalents—Dacite and monzonite porphyry

Rhyolite Canyon Tuff

ROCKS THAT PRE-DATE THE TURKEY CREEK CALDERA

Volcanic rocks—Mainly Oligocene rhyolite and dacite

Basement rocks—Mainly Mesozoic and Paleozoic sedimentary rocks; includes some Precambrian granite

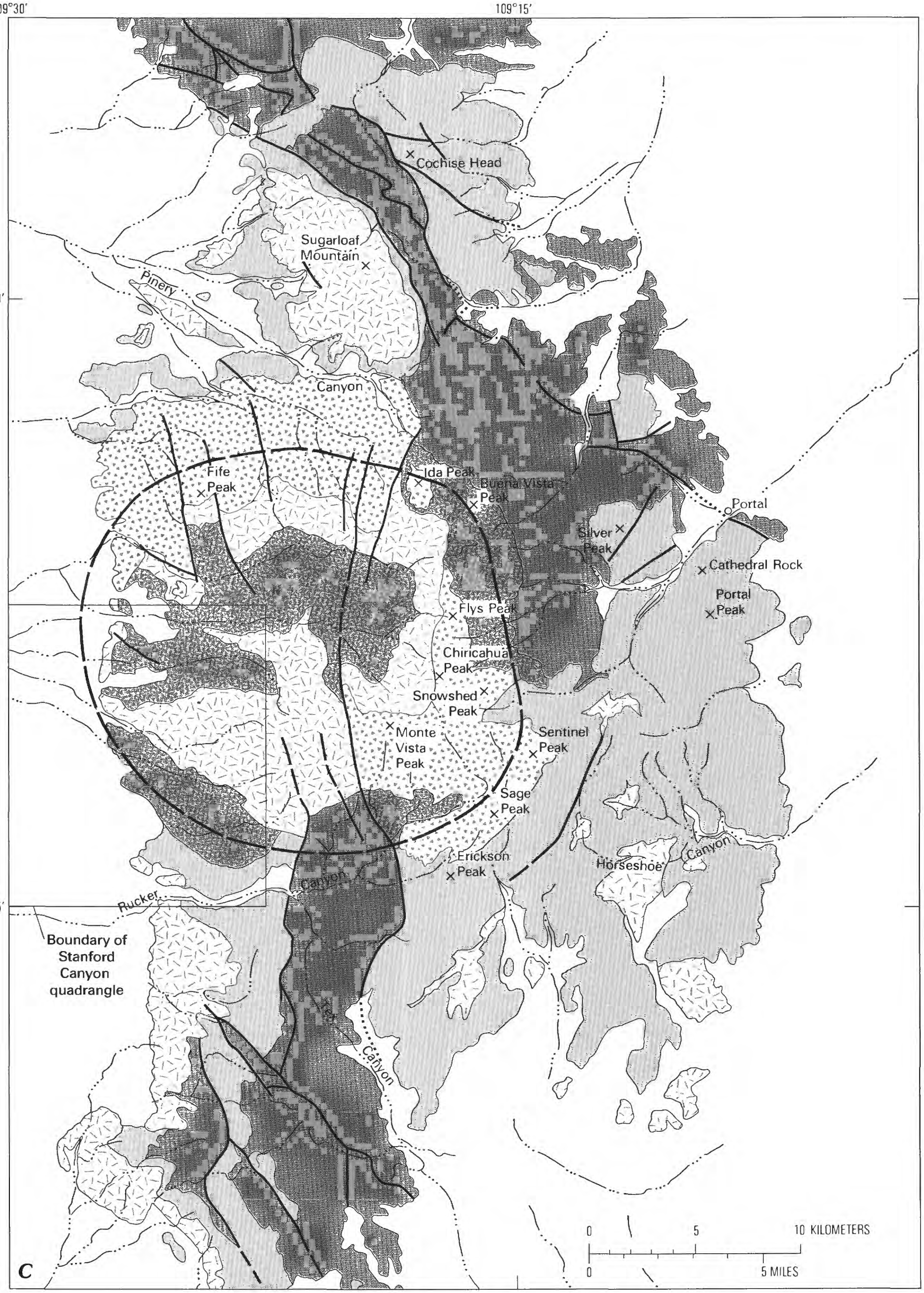
Contact

Structural margin of Turkey Creek caldera

Fault—Dashed where approximately located; dotted where concealed

Streams

The structural and topographic margins of the Turkey Creek caldera are present, in part, in the Stanford Canyon quadrangle. The structural margin consists of the ring-fault system along which the floor of the developing caldera collapsed during the eruption of the Rhyolite Canyon Tuff. Caldera collapse caused development of a deep central depression in which as much as 1.5 km of intracaldera tuff accumulated. Outside the structural margin, toward the topographic margin, the thickness of intracaldera tuff decreases. The structural margin is either concealed by younger deposits or has been intruded by dacite porphyry throughout most of its extent.


109°30′
109°15′
32°00′
31°45′
Cochise Head
Sugarloaf Mountain
Pinery
Canyon
Fife Peak
Ida Peak
Buena Vista Peak
Portal
Silver Peak
Cathedral Rock
Portal Peak
Flys Peak
Chiricahua Peak
Snowshed Peak
Monte Vista Peak
Sentinel Peak
Sage Peak
Erickson Peak
Horseshoe
Canyon
Rucker
Canyon
Boundary of Stanford Canyon quadrangle
Canyon
0 5 10 KILOMETERS
0 5 MILES
C

The topographic margin is denoted by an unconformity between caldera fill (intracaldera tuff, wall breccia, or moat deposits) and any older rock. The topographic rim retreated from the structural margin, through massive landsliding into the depression that developed during caldera collapse. In this process, large amounts of older rock exposed in the walls of the depression presumably slumped off and become mixed with intracaldera ash to form megabreccia and mesobreccia. As eruption and collapse waned, a thin (<1 km) interval of intracaldera facies Rhyolite Canyon Tuff was deposited on older rock that formed the runout surfaces and headwall scarps of the landslides. The headwall scarps form the topographic margin of the caldera and are located outside the structural margin. Resurgent emplacement of dacite porphyry magma as a laccolith, ring dike, and lava flows created a moat that filled with high-silica rhyolite lava flows and minor tuff that banked against the topographic margin.

Several geologic observations made within the Stanford Canyon quadrangle provide new insights into the evolution of the Turkey Creek caldera as well as regional correlations of slightly older middle Tertiary volcanic rocks that host the caldera. These observations are discussed below.

Major-oxide and trace-element data presented here (tables 2 and 3) for the welded tuff of Rucker Canyon (map unit Trr of du Bray and Pallister, in press b) are remarkably similar to those (du Bray and others, 1992a) of the Jesse James Canyon Tuff. Like the Jesse James Canyon Tuff, which crops out in the area of Chiricahua National Monument (fig. 1) about 20 km to the north in the Rustler Park quadrangle (Pallister and others, in press), the welded tuff of Rucker Canyon also occurs immediately beneath outflow facies of Rhyolite Canyon Tuff. On the basis of similarities of stratigraphic position, composition, and petrographic attributes, we tentatively suggest that these two map units are parts of the same ash-flow tuff.

Similarly, exposures of the lower member of the rhyolite of Joe Glenn Ranch (map unit Tjl, du Bray and Pallister, in press b) may be correlative with areally limited exposures of the welded tuff of Riggs Spring, also mapped in the Rustler Park quadrangle (fig. 1). Both of these tuffs are characterized by abundant biotite, and their stratigraphic relations and major-oxide and trace-element abundances (tables 2 and 3; du Bray and others, 1992a) are similar. Consequently, we tentatively suggest that these two map units are parts of the same ash-flow tuff.

Trace-element abundances (table 3) in samples of moat rhyolite tuff (map unit Tmt_1) from the Stanford Canyon quadrangle are distinct and highly variable relative to those for stratigraphically equivalent rocks that crop out elsewhere within the Turkey Creek caldera (du Bray and others, 1992a, 1992b, 1993). The distinctiveness and variability of trace-element abundances in samples of unit Tmt_1 from the Stanford Canyon quadrangle may derive from several factors. First, these samples may be more contaminated by lithic fragments than samples from elsewhere in the caldera. Second, ash deposits represented by these abnormally crystal-poor tuffs may be ash-fall deposits derived from erupted material that experienced significant phenocryst elutriation. Third, some of the compositional distinctiveness of these samples may represent hydrothermal or deuteric alteration. Finally, although stratigraphic relations allow correlation of these deposits with other Tmt_1 exposures, it is possible that they actually represent a different unit that is fortuitously similar to Tmt_1 deposits with regard to gross petrographic features and stratigraphic position.

A final geologic observation of note involves the close spatial proximity between the two phases, resurgent laccolith and moat-filling lava flow, of the dacite porphyry at the mouth of Cottonwood Canyon (du Bray and Pallister, in press b). Dacite porphyry in these two settings is separated by an unusually narrow septum of intracaldera facies Rhyolite Canyon Tuff. The occurrence of clearly intrusive and clearly extrusive dacite porphyry at the same level of exposure seems contradictory. One explanation for this apparent enigma is that dacite porphyry was first emplaced as a series of moat-filling lava flows and was subsequently intruded by comagmatic dacite porphyry of the core laccolith. Such a scenario requires that a significant amount of intracaldera tuff was stoped, to the extent that only a narrow selvedge of tuff remains separating intrusive and extrusive dacite porphyry.

ANALYTIC DATA

About 120 rock samples were collected during geologic mapping of the Stanford Canyon quadrangle. Energy-dispersive trace-element analyses were conducted for 90 samples. Major-oxide abundances were determined for 38 samples. Instrumental neutron activation analyses were conducted for four samples. Abundances of CO_2, FeO, F, and Cl were determined for three samples using various wet chemical methods. Most of the chemical data were used to aid map-unit characterization and stratigraphic correlation.

Our sample collecting was designed to provide areal representation of the igneous rocks exposed in the quadrangle. By collecting and analyzing numerous samples from each map unit we have established the limits of chemical variability of these units. This procedure is especially important in sampling ash-flow tuffs, many of which are derived from chemically zoned magma chambers (Hildreth, 1981). Chemical data also facilitated lithologic/stratigraphic distinctions that in several instances could not be made during field investigations.

All of the geochemical data presented here were determined in analytical laboratories of the U.S. Geological Survey in Denver, Colo. Major-oxide analyses (table 2) were performed (analysts, J.E. Taggart, A.J. Bartel, J.S. Mee, and D.F. Siems) using X-ray fluorescence techniques (Taggart and others, 1987). Molar Fe^{2+} versus total iron as Fe^{2+} ratios were adjusted to 0.8 and major-oxide abundances recalculated to 100 percent, on an anhydrous basis. Abundances of selected trace elements (table 3) were determined (by E.A. du Bray and Kim Linton) by energy-dispersive X-ray fluorescence spectroscopy (Elsass and du Bray, 1982) using ^{109}Cd and ^{241}Am radio-isotope excitation sources; the accuracy of this type of data is discussed by Sawyer and Sargent (1989). Abundances of selected trace elements presented in table 4 were determined (analysts, J.R. Budahn, R.J. Knight, and D.M. McKown) by instrumental neutron activation analysis (Baedecker and McKown, 1987). Abundances of FeO (as ferrous iron), CO_2, F, and Cl (table 5) were determined (analysts, E.L. Brandt and J.D. Sharkey) by wet chemical methods (Jackson and others, 1987).

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Table 1. Status and treatment of samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona

[X, data or sample type available, blank if unavailable. WRM, whole-rock major-oxide analysis (table 2); NA, neutron activation analysis (table 4); KEV, energy-dispersive trace-element analysis (table 3); TS, thin section and hand sample available; PTS, polished thin section and hand sample available; REF, reference hand sample available. Map-unit symbols (in parentheses) used on Stanford Canyon geologic map (du Bray and Pallister, in press b)]

Sample number	WRM	NA	KEV	Other data*	TS	PTS	REF	COMMENTS
Aphyric rhyolite lava, unit 1 (Tmr1)								
202169			X					DIKE.
P636			X				X	DIKE; TRACE-ELEMENT CHEMISTRY LIKE THAT OF TMR1.
Aphyric rhyolite tuff, unit 1 (Tmt_1)								
202180			X		X			ATYPICAL TRACE ELEMENT CHEMISTRY.
202216			X					ATYPICAL TRACE ELEMENT CHEMISTRY.
202217			X					ATYPICAL TRACE ELEMENT CHEMISTRY.
202221			X					ATYPICAL TRACE ELEMENT CHEMISTRY.
202222			X					ATYPICAL TRACE ELEMENT CHEMISTRY.
P646			X					ATYPICAL TRACE ELEMENT CHEMISTRY.
Sedimentary rocks (Tms)								
202180B					X			ASH-RICH SANDSTONE.
202180C					X			ASH-POOR SANDSTONE.
Dacite and monzonite porphyry, resurgent intrusion (Tdpi)								
201525	X	X	X	1, 2		X		
201526	X	X	X	1, 2		X		
202157			X					
202158	X		X		X			
202160			X					
202161			X					
202162			X					
202163	X		X					
P235A					X			
P235B					X			
P235C					X			
P235D					X			
P363					X			CONTAINS HEMATITE VEINS.
T8-27				†				
Dacite porphyry lava flows, John Long mass (Tdpl)								
201982	X		X		X			
202168	X		X		X			
202178	X		X		X			
202179			X		X			
202187	X		X		X			GLASS.
202189					X			SCORIA.
202194			X					
202203			X					

Table 1. Status and treatment of samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona—Continued

Sample number	WRM	NA	KEV	Other data*	TS	PTS	REF	COMMENTS
Dacite porphyry lava flows, John Long mass (Tdpl)--Continued								
202204			X					
P647							X	SLAB; SCORIA.
Ash-rich sandstone (Tas)								
202206					X			SANDSTONE.
Rhyolite Canyon Tuff, lava-like phase (Trcf)								
202176	X		X		X			
202177	X		X		X			
202201			X		X			
202202			X					
202205			X		X			GLASS.
P630							X	TRCF WITH CLOT.
P632			X		X			
P633			X					
P634							X	FLOW-BANDED TRCF.
P637			X		X			
Rhyolite Canyon Tuff, middle member outflow facies (Trcm)								
202198			X		X			
202199			X					
202200			X					
202214	X		X		X			TOP.
202219			X					ATYPICAL TRACE-ELEMENT CHEMISTRY.
Rhyolite Canyon Tuff, lower member outflow facies (Trcl)								
201604	X	X	X	1, 2		X		LUMP PUMICES; ATYPICAL CHEMISTRY.
201605	X	X	X			X		HOST TO 201604.
202208	X		X				X	BASE.
202209	X		X		X			ATYPICAL CHEMISTRY.
202210	X		X		X			
202211	X		X		X			
202212	X		X		X			
202213	X		X		X			
202218			X					
202220			X					
P644							X	BRICK-RED BASE OF TRCO.
Rhyolite Canyon Tuff, outflow facies, undivided (Trco)								
202188	X		X		X			
202193	X		X		X			

Table 1. Status and treatment of samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona—Continued

Sample number	WRM	NA	KEV	Other data*	TS	PTS	REF	COMMENTS
Rhyolite Canyon Tuff, intracaldera facies (Trci)								
201777A-C					X			MATRIX TO BLOCKS IN CRUSH ZONE; T8-26†.
201777D-E					X			FROM CORES OF BLOCKS IN CRUSH ZONE.
201778A					X			CRUSHED TRCI?
201778B	X		X		X			BLOCK IN BRECCIA ZONE--TRCI?
202159	X		X		X			
202164			X		X			RECRYSTALLIZED TRCI.
202165			X		X			
202166			X		X		X	GLASS; ALTERED.
202171	X		X					
202173	X		X		X			
202174			X					
202175			X					
P618						X		RECRYSTALLIZED TRCI.
P622						X		VITROPHYRIC TRCI.
P624	X		X		X			ALTERED AND RECRYSTALLIZED GLASS AT TDPI CONTACT.
P626							X	MODERATELY WELDED ASH FLOW AT BASE OF TRCI.
P627			X					
P627B			X					MAGMA CLOT IN TRCI.
P628			X					
Welded tuff of Rucker Canyon (Trr)								
202190	X		X		X			
202192	X		X		X			
202196	X		X		X			BASAL UNWELDED ASH; ALTERED.
202197	X		X		X			
202215			X		X			
Rhyolite of Joe Glenn Ranch (Tjl)								
202167	X		X		X			MEGABRECCIA BLOCK IN TRCI.
202182	X		X		X			
202183			X					
Rhyolite tuff of High Lonesome Canyon (Thl)								
202043	X		X		X			CRYSTAL-POOR UPPER PART.
202044	X		X		X			MODERATELY CRYSTAL RICH LOWER PART.
P638B			X				X	BASE OF BOTTOM TO TOP SECTION THROUGH THL.
P638C			X				X	MIDDLE OF BOTTOM TO TOP SECTION THROUGH THL.
P638D			X				X	MIDDLE OF BOTTOM TO TOP SECTION THROUGH THL.
P638F			X				X	MIDDLE OF BOTTOM TO TOP SECTION THROUGH THL.
P638G			X				X	MIDDLE OF BOTTOM TO TOP SECTION THROUGH THL.
P638H			X				X	MIDDLE OF BOTTOM TO TOP SECTION THROUGH THL.
P638I			X				X	MIDDLE OF BOTTOM TO TOP SECTION THROUGH THL.
P638J			X				X	TOP OF BOTTOM TO TOP SECTION THROUGH THL.

Table 1. Status and treatment of samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona—Continued

Sample number	WRM	NA	KEV	Other data*	TS	PTS	REF	COMMENTS
								Faraway Ranch Formation, volcanic rocks (Tfv)
202045			X		X			
202170			X		X			BLOCK IN TRCI.
202172	X		X		X			HORNBLENDE ANDESITE LAVA.
202181			X		X			
202184	X		X		X			HORNBLENDE ANDESITE LAVA.
202186					X			BIOTITE-HORNBLENDE ANDESITE LAVA GLASS WITHIN TFV2.
202191	X		X					ANDESITE LAVA.
P638A			X				X	
								Miscellaneous
202185	X		X		X			PYROCLASTIC FLOW ROCK.
202230			X				X	PYROCLASTIC FLOW ROCK.
P619A							X	DIKE IN TRCI.
P619B					X			ANATECTIC DIKE.
P620					X			DIKE IN TRCI.
P621							X	HEMATITE-QUARTZ BRECCIA AT TRCI/TDPI CONTACT.
P626B			X				X	BIOTITE-SANIDINE TUFF CLAST IN TRCI WALL BRECCIA.
P638E					X			SANDSTONE BETWEEN THL ASH FLOWS.

* Other geochemical data, identified by following codes:
1. Ferrous iron and carbon dioxide analyses (table 5).
2. Fluorine and chlorine analyses (table 5).

† Sample collected at same locality for paleomagnetic studies. See Pallister and du Bray (1989) for discussion of paleomagnetic data (J.G. Rosenbaum, U.S. Geological Survey, unpub. data).

Table 2. Major-oxide analyses for selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona

[Data in weight percent. Fe^{2+} /total iron (as FeO) adjusted to 0.8 and abundances normalized to 100 weight percent, anhydrous. Map-unit symbols above data columns match those shown on the Stanford Canyon geologic map (du Bray and Pallister, in press b) and are defined in table 1. LOI, loss on ignition; ND, not detected. X-ray fluorescence spectroscopy, J.E. Taggart, A.J. Bartel, J.S. Mee, D.F. Siems, analysts]

Map unit	Tdpi				Tdpl, John Long mass			
Sample No.	201525	201526	202158	202163	201982	202168	202178	202187
SiO_2---	71.53	68.86	64.02	69.78	63.53	64.27	69.22	65.01
Al_2O_3--	13.88	14.94	15.70	14.63	16.19	16.20	15.08	15.38
Fe_2O_3--	.61	.72	1.18	.78	1.02	1.05	.79	1.06
FeO----	2.21	2.59	4.24	2.81	3.66	3.77	2.85	3.82
MgO----	.65	.95	1.50	.58	1.54	.87	.48	1.72
CaO----	1.16	1.47	2.76	1.06	2.83	2.93	1.29	3.27
Na_2O---	3.24	3.37	4.16	3.28	4.11	4.16	3.59	3.98
K_2O----	5.91	6.10	4.79	6.16	5.73	5.20	5.64	4.32
TiO_2---	.58	.71	1.14	.65	.95	1.01	.73	.96
P_2O_5---	.17	.23	.43	.21	.36	.42	.26	.36
MnO----	.04	.07	.09	.04	.09	.12	.07	.11
LOI----	1.05	1.76	1.04	1.23	1.49	2.12	1.53	1.92

Map unit	Trcf		Trcm	Trcl				
Sample No.	202176	202177	202214	201604	201605	202208	202209	202210
SiO_2---	75.88	75.09	77.59	76.86	77.34	77.32	76.68	76.71
Al_2O_3--	12.49	13.01	11.96	12.37	12.20	12.34	12.07	12.02
Fe_2O_3--	.48	.48	.37	.29	.30	:36	.39	.36
FeO----	1.73	1.72	1.32	1.04	1.10	1.28	1.41	1.30
MgO----	.10	ND	.10	.13	.18	.27	.17	.16
CaO----	.11	.10	.09	.55	.16	.18	.37	.60
Na_2O---	3.64	3.65	3.50	3.72	3.59	2.65	3.51	3.49
K_2O----	5.26	5.60	4.88	4.90	4.93	5.37	5.09	5.10
TiO_2---	.23	.28	.14	.09	.12	.14	.14	.15
P_2O_5---	ND	ND	ND	ND	ND	ND	.09	ND
MnO----	.07	.07	.05	.06	.08	.09	.08	.10
LOI----	.83	.45	.75	.54	.65	1.44	.93	.83

Map unit	Trcl			Trco		Trci		
Sample No.	202211	202212	202213	202188	201193	202778B	202159	202171
SiO_2---	76.63	76.90	76.85	77.18	77.03	76.22	76.55	77.57
Al_2O_3--	12.16	12.09	12.26	11.91	11.79	13.06	12.08	11.85
Fe_2O_3--	.40	.37	.39	.38	.36	.43	.45	.38
FeO----	1.42	1.34	1.39	1.38	1.30	1.54	1.64	1.36
MgO----	.14	.12	ND	ND	.14	.19	ND	ND
CaO----	.39	.39	.04	.06	.33	.34	.16	.11
Na_2O---	3.69	3.60	3.76	3.75	3.62	2.80	3.83	3.44
K_2O----	4.94	4.98	5.09	5.11	5.03	5.10	4.99	5.11
TiO_2---	.15	.15	.14	.14	.14	.24	.23	.15
P_2O_5---	ND	ND	ND	ND	.18	.05	ND	ND
MnO----	.08	.07	.08	.08	.08	.04	.07	.03
LOI----	.61	.61	.54	.46	.55	1.76	.41	.39

Table 2. Major-oxide analyses for selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona—Continued

Map unit	Trci		Trr				Tjl	
Sample No.	202173	P624	202190	202192	202196	202197	202167	202182
SiO_2---	76.58	71.49	76.26	77.16	77.70	77.04	74.27	71.06
Al_2O_3--	12.02	15.28	12.96	11.81	12.78	12.01	13.26	15.62
Fe_2O_3--	.47	.46	.26	.38	.23	.27	.45	.53
FeO----	1.70	1.66	.94	1.36	.82	.96	1.64	1.92
MgO----	ND	.41	ND	ND	.76	ND	.30	.27
CaO----	.24	1.78	.23	.12	2.47	.15	.39	1.25
Na_2O---	3.60	4.00	3.23	3.56	.62	1.79	1.74	3.54
K_2O----	5.12	4.40	5.82	5.30	4.34	7.47	7.46	5.29
TiO_2---	.22	.35	.22	.14	.17	.16	.34	.39
P_2O_5---	ND	.11	ND	.08	ND	.08	.11	.08
MnO----	.04	.06	.07	.08	.12	.06	.04	.05
LOI----	.42	.81	.80	.49	10.60	1.26	1.26	1.14

Map unit	Thl		Tfv			Miscellaneous
Sample No.	202043	202044	202072	202184	202191	202185
SiO_2---	74.42	76.82	67.59	61.34	61.63	70.09
Al_2O_3--	13.25	12.87	16.05	17.47	17.56	15.09
Fe_2O_3--	.31	.26	1.04	1.21	1.33	0.55
FeO----	1.13	.93	3.74	4.37	4.80	1.97
MgO----	.31	.51	.52	2.97	1.21	0.80
CaO----	.17	1.30	3.57	4.88	5.09	0.31
Na_2O---	1.05	1.83	2.79	3.74	3.86	0.15
K_2O----	9.16	5.32	3.75	2.71	3.19	10.47
TiO_2---	.16	.15	.62	.90	.97	.38
P_2O_5---	ND	ND	.27	.26	.28	.13
MnO----	.03	.03	.05	.14	.07	.06
LOI----	1.36	4.60	4.20	2.93	1.20	1.63

Table 3. Trace-element data for selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona

[Data in parts per million. Map-unit symbols match those on the Stanford Canyon geologic map (du Bray and Pallister, in press b) and are defined in table 1. ND, not detected. Energy-dispersive X-ray fluorescence; E.A. du Bray and Kim Linton, analysts]

Map unit	Tmr1		Tmt1					
Sample No.	202169	P636	202180	202216	202217	202221	202222	P646
Zn----	54	87	78	171	75	158	66	68
Rb----	351	357	465	215	605	450	482	604
Sr----	56	32	272	31	31	459	20	26
Y-----	47	62	73	91	109	119	95	137
Zr----	164	143	144	223	190	191	115	169
Nb----	30	24	67	37	88	72	64	76
Pb----	44	35	71	58	47	68	30	70
Th----	61	48	75	48	78	59	54	70
Ba----	100	55	1763	61	36	212	83	31
La----	87	66	32	68	52	41	37	79
Ce----	112	95	69	209	89	91	48	83
Nd----	81	42	56	56	62	36	27	69

Map unit	Tdpi							
Sample No.	201525	201526	202157	202158	202160	202161	202162	202163
Zn----	94	118	83	82	53	60	90	100
Rb----	348	299	278	144	100	231	125	285
Sr----	167	159	148	224	113	192	196	149
Y-----	49	56	61	43	25	53	28	43
Zr----	442	479	467	373	208	487	362	495
Nb----	28	26	23	25	12	27	16	20
Pb----	45	45	15	15	30	15	15	49
Th----	39	27	14	14	14	14	14	14
Ba----	615	672	810	844	898	756	844	616
La----	87	112	122	91	71	111	78	82
Ce----	162	184	177	153	168	204	157	210
Nd----	72	86	81	65	54	84	83	56

Map unit	Tdpl, John Long mass							
Sample No.	201982	202168	202178	202179	202187	202194	202203	202204
Zn----	125	93	157	73	66	109	67	66
Rb----	188	141	123	208	142	217	101	160
Sr----	201	246	92	176	197	192	135	132
Y-----	47	58	21	61	31	51	28	48
Zr----	627	601	255	493	336	529	317	380
Nb----	28	25	15	25	16	33	16	21
Pb----	59	15	15	73	15	15	26	15
Th----	20	14	14	14	14	27	14	14
Ba----	842	1261	802	934	763	886	919	758
La----	90	118	90	115	85	70	95	101
Ce----	153	173	182	201	160	193	159	201
Nd----	69	62	95	84	69	66	82	93

Map unit	Trcf							
Sample No.	202176	202177	202201	202202	202205	P632	P633	P637
Zn----	119	74	84	80	138	126	104	107
Rb----	293	280	251	305	349	286	301	411
Sr----	39	37	36	40	32	34	35	32
Y-----	50	61	53	62	63	68	61	86
Zr----	408	400	463	491	472	396	408	377
Nb----	41	37	36	36	39	41	46	41
Pb----	15	38	45	37	34	15	15	35
Th----	14	14	14	14	24	14	14	14
Ba----	34	59	91	145	20	20	30	54
La----	95	136	99	115	100	108	122	131
Ce----	202	229	175	179	212	250	206	223
Nd----	47	104	56	106	67	83	94	56

Table 3. Trace-element data for selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona—*Continued*

Map unit	Trcm					Trcl		
Sample No.	202198	202199	202200	202214	202219	201604	201605	202208
Zn----	60	100	81	56	35	25	83	125
Rb----	397	368	410	383	249	551	395	360
Sr----	24	28	16	21	15	16	27	28
Y-----	99	77	61	66	50	76	107	73
Zr----	268	251	260	290	190	227	280	237
Nb----	59	51	53	56	37	87	61	53
Pb----	56	28	41	55	26	54	15	65
Th----	66	56	45	61	54	100	64	71
Ba----	24	29	19	13	20	6	45	23
La----	46	69	76	36	69	36	80	70
Ce----	124	120	126	100	131	109	145	137
Nd----	31	55	59	54	47	30	76	56

Map unit	Trcl							Trco
Sample No.	202209	202210	202211	202212	202213	202218	202220	202188
Zn----	85	80	97	80	62	111	80	74
Rb----	270	418	402	389	394	409	400	403
Sr----	21	24	28	20	14	18	37	29
Y-----	65	118	106	109	43	114	71	32
Zr----	178	273	288	280	262	283	274	275
Nb----	34	60	54	61	56	60	54	51
Pb----	39	15	15	36	20	50	42	51
Th----	40	43	50	42	41	65	42	40
Ba----	24	42	33	16	20	27	29	17
La----	56	61	101	45	54	95	72	45
Ce----	127	142	143	172	131	161	151	138
Nd----	37	47	48	15	45	67	57	45

Map unit	Trco	Trci						
Sample No.	202193	201778B	202159	202164	202165	202166	202171	202173
Zn----	85	125	100	72	70	52	118	94
Rb----	374	328	259	361	299	215	399	256
Sr----	34	48	37	40	27	115	33	40
Y-----	70	61	55	70	51	40	74	50
Zr----	270	356	375	331	324	287	273	352
Nb----	53	47	32	45	38	28	52	41
Pb----	28	15	15	26	40	30	49	25
Th----	55	44	14	14	33	14	31	14
Ba----	51	103	31	128	51	90	65	50
La----	76	85	88	81	132	121	77	77
Ce----	138	163	235	188	200	232	113	150
Nd----	56	61	58	49	108	67	57	53

Map unit	Trci						Trr	
Sample No.	202174	202175	P624	P627	P627B	P628	202190	202192
Zn----	87	58	98	75	60	80	68	85
Rb----	357	193	207	485	604	606	321	403
Sr----	31	32	237	62	41	36	21	36
Y-----	56	42	35	54	60	54	38	96
Zr----	308	360	279	418	354	281	231	295
Nb----	40	29	13	37	38	47	33	51
Pb----	15	15	54	44	27	29	56	43
Th----	14	14	14	14	14	14	52	74
Ba----	48	61	956	156	128	74	97	13
La----	81	125	52	111	82	79	57	81
Ce----	144	175	110	223	221	150	74	133
Nd----	70	57	61	68	82	70	13	51

Table 3. Trace-element data for selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona—Continued

Map unit	Trr			Tjl			Thl	
Sample No.	202196	202197	202215	202167	202182	202183	202043	202044
Zn----	105	53	58	18	58	52	59	66
Rb----	164	389	328	458	209	529	485	219
Sr----	956	20	39	95	160	71	52	200
Y-----	75	30	42	49	32	12	48	28
Zr----	150	140	172	184	215	124	118	113
Nb----	25	29	34	12	20	6	18	16
Pb----	57	41	32	26	38	39	31	42
Th----	34	34	34	14	14	14	31	39
Ba----	112	31	96	775	822	1090	822	264
La----	56	31	43	52	63	39	38	42
Ce----	86	84	97	76	106	74	59	48
Nd----	27	21	23	75	60	48	31	26

Map unit	Thl							
Sample No.	P638B	P638C	P638D	P638F	P638G	P638H	P638I	P638J
Zn----	32	56	35	72	84	49	65	66
Rb----	240	218	229	354	265	320	519	436
Sr----	169	171	53	367	428	489	51	53
Y-----	26	31	33	46	43	45	40	33
Zr----	114	110	100	106	99	104	112	111
Nb----	18	15	17	17	17	18	16	17
Pb----	34	43	44	41	36	41	38	43
Th----	25	30	24	14	14	24	14	30
Ba----	230	276	158	900	640	863	864	893
La----	43	27	24	68	34	46	38	31
Ce----	38	47	74	31	46	25	67	65
Nd----	17	37	10	37	35	42	30	28

Map unit	Tfv							Miscellaneous
Sample No.	202045	202170	202172	202181	202184	202191	P638A	202185
Zn----	69	65	70	65	49	109	156	96
Rb----	136	155	166	190	119	158	92	641
Sr----	434	407	350	322	471	415	570	52
Y-----	28	41	30	37	34	40	23	33
Zr----	155	175	157	182	179	217	208	309
Nb----	16	14	11	15	13	12	10	14
Pb----	37	49	59	32	67	19	26	15
Th----	28	14	14	14	14	45	14	14
Ba----	832	935	721	824	675	634	726	868
La----	47	64	47	45	35	40	56	50
Ce----	80	69	75	80	70	68	78	97
Nd----	23	72	31	56	52	47	14	40

Map unit	Miscellaneous	
Sample No.	202230	P626B
Zn----	74	38
Rb----	146	187
Sr----	360	59
Y-----	34	31
Zr----	297	142
Nb----	13	15
Pb----	15	56
Th----	14	27
Ba----	769	403
La----	56	27
Ce----	104	73
Nd----	50	50

Table 4. Instrumental neutron activation data for selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona

[Data in parts per million. Map-unit symbols above data columns match those used on the Stanford Canyon geologic map (du Bray and Pallister, in press b) and are defined in table 1. ND, not detected. J.R. Budahn, R.J. Knight, and D.M. McKown, analysts]

Map unit	Tdpi		Trcl	
Sample No.	201525	201526	201604	201605
Ba----	667	695	112	47.8
Sr----	175	145	ND	ND
Co----	4.49	5.16	.644	.779
Ni----	17.3	9.50	ND	3.80
Cr----	4.23	3.96	ND	.974
Cs----	7.65	10.2	4.06	10.9
Hf----	12.3	12.6	11.4	10.0
Rb----	352	295	567	374
Sb----	.736	.246	.328	.179
Ta----	2.34	2.41	7.98	4.74
Th----	35.2	35.0	82.3	48.2
U-----	4.85	3.45	12.8	10.5
Zn----	62.3	70.3	32.3	63.9
Zr----	495	562	262	288
Sc----	6.09	6.95	1.78	1.94
La----	85.8	110	28.4	62.0
Ce----	189	205	103	135
Nd----	76.2	87.1	24.6	45.3
Sm----	12.8	14.2	8.19	11.6
Eu----	1.49	1.64	.131	.197
Gd----	10.0	12.1	10.6	12.0
Tb----	1.47	1.82	2.44	2.18
Tm----	.804	1.00	2.10	1.54
Yb----	5.11	6.12	13.50	9.95
Lu----	.780	.903	1.86	1.40

Table 5. Abundances of FeO, CO_2, F, and Cl in selected samples collected in the Stanford Canyon quadrangle, Chiricahua Mountains, Cochise County, Arizona

[Data in weight percent. ND, not detected. Map-unit symbols above data columns match those used on the Stanford Canyon geologic map (du Bray and Pallister, in press b) and are defined in table 1. Wet chemical determinations; E.L. Brandt and J.D. Sharkey, analysts]

Map unit	Tdpi		Trcl
Sample No.	201525	201526	201604
FeO---	0.64	0.24	0.02
CO_2---	.20	.23	ND
F-----	.03	.07	.19
Cl----	.01	ND	ND

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