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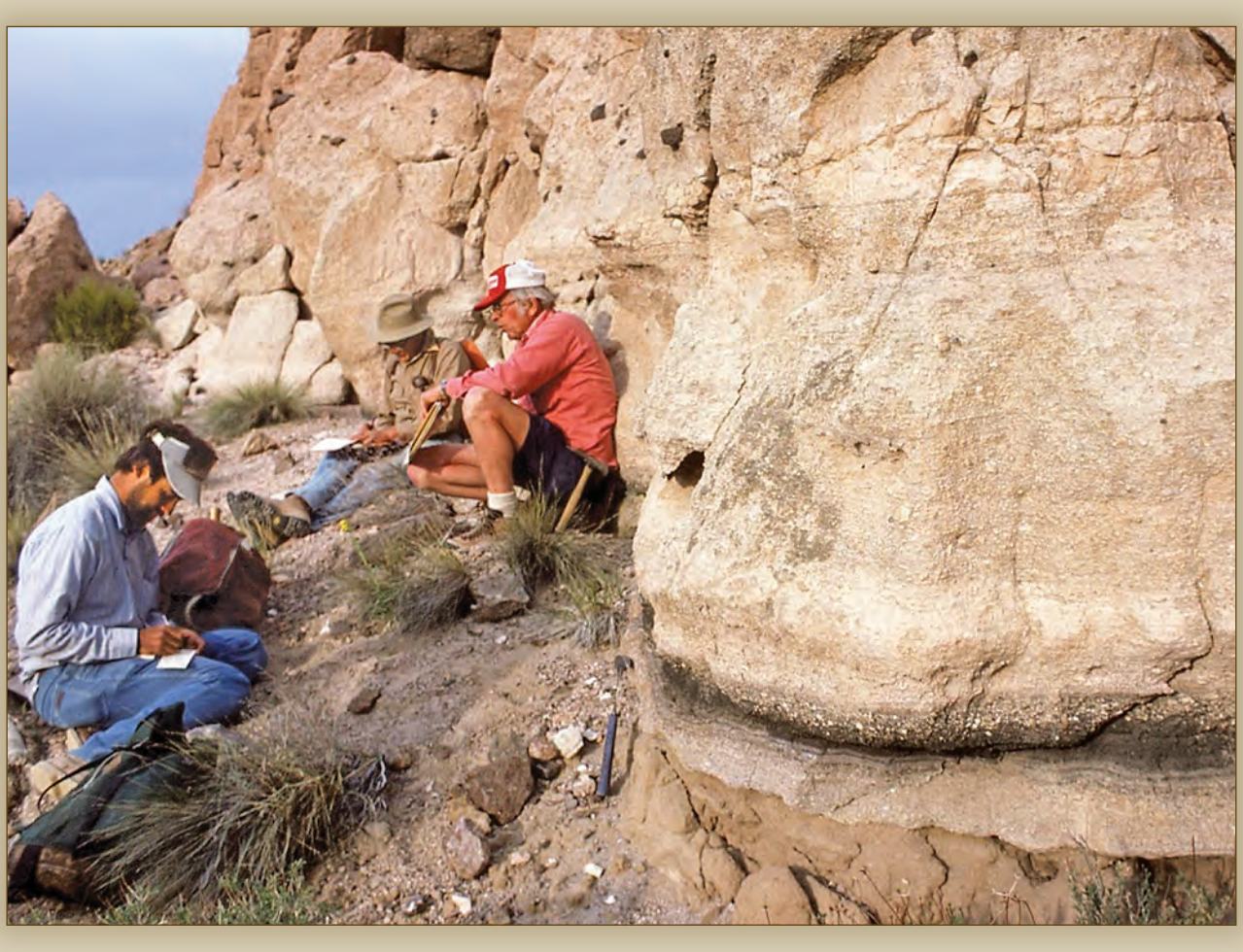
Prepared in cooperation with the U.S. Department of Energy, National Nuclear Security Administration Site Office, Office of Environmental Management under Interagency Agreement DE-AI52-12NA30865/DE-NA0001654

Hydrogeologic Applications for Historical Records and Images from Rock Samples Collected at the Nevada National Security Site and Vicinity, Nye County, Nevada—A Supplement to Data Series 297



Open-File Report 2018–1011

U.S. Department of the Interior
U.S. Geological Survey

Front Cover: Geologists from the U.S. Geological Survey (USGS) and Los Alamos National Laboratory collecting sample POG2B10 of andesite tephra beneath Rainier Mesa Tuff (Tmra) at base of mafic-poor Rainier Mesa Tuff (Tmrp), Nye County, Nevada, April 1986

Back Cover: U.S. Geological Survey geologists describing Crater Flat Caldera at Nevada National Security Site, Nye County, Nevada, November 1984.

Hydrogeologic Applications for Historical Records and Images from Rock Samples Collected at the Nevada National Security Site and Vicinity, Nye County, Nevada—A Supplement to Data Series 297

By David B. Wood

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U.S. Department of the Interior
RYAN K. ZINKE, Secretary

U.S. Geological Survey
William H. Werkheiser, Deputy Director
exercising the authority of the Director

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Conversion Factors

U.S. Customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)

Datums

Vertical coordinates are referenced to the North American Vertical Datum of 1929 (NGVD29); see altitude at portal opening, altitude of land surface, and reference point elevation in tables.

Horizontal coordinates are referenced to both the North American Datum of 1927 (NAD27) and 1983 (NAD83); see Nevada State Plane coordinates, latitude/longitude, decimal latitude/ longitude, and UTM coordinates in tables.

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations

CVP	Comprehensive Volcanic Petrographics, LLC
LANL	Los Alamos National Laboratory
NNSA	National Nuclear Security Agency
NNSS	Nevada National Security Site
NNSS PGG	Nevada National Security Site Petrographic, Geochemical, and Geophysical Database
NNSS USGS	Nevada National Security Site U.S. Geological Survey Databases
USGS	U.S. Geological Survey

Hydrogeologic Applications for Historical Records and Images from Rock Samples Collected at the Nevada National Security Site and Vicinity, Nye County, Nevada—A Supplement to Data Series 297

By David B. Wood

Abstract

Rock samples have been collected, analyzed, and interpreted from drilling and mining operations at the Nevada National Security Site for over one-half of a century. Records containing geologic and hydrologic analyses and interpretations have been compiled into a series of databases. Rock samples have been photographed and thin sections scanned. Records and images are preserved and available for public viewing and downloading at the U.S. Geological Survey ScienceBase, Mercury Core Library and Data Center Web site at https://www.sciencebase.gov/mercury/ and documented in U.S. Geological Survey Data Series 297. Example applications of these data and images are provided in this report.

Introduction

More than 60 years of rock samples collected from drilling and mining operations and records derived from sample analyses and interpretation are preserved and available for public viewing and downloading at the U.S. Geological Survey (USGS) ScienceBase, Mercury Core Library and Data Center Web site (https://www.sciencebase.gov/mercury/) and documented in Wood (2007). Because the USGS was designated as custodian of the rock samples, the USGS also amassed paper copies of reports, records, and analyses from the National Laboratories as well as U.S. Department of Energy and U.S. Department of Defense contractors (Wood, 2007).

The data and images available at the Mercury Core Library and Data Center Web site and described in Wood (2007) can be used in a multitude of applications by scientists and engineers. Example applications of these data and images are described in this report.

Archival Records and Images

Records and images represent more than 60 years of research at the Nevada National Security Site (NNSS). This includes images of photographs of the rock samples, scanned images of thin sections, rock-sample storage locations, lithologic descriptions, physical and mechanical rock properties, fracture characteristics, and hydraulic properties compiled by USGS; and petrographic, geochemical, and geophysical records compiled by Los Alamos National Laboratory (LANL) and updated by R.G. Warren (Comprehensive Volcanic Petrographics LLC [CVP]).

Nevada National Security Site U.S. Geological Survey Databases

The NNSS USGS Databases merely combines the five independent Microsoft® Excel® spreadsheets into Microsoft® Access® tables and moves most redundant data into a separate Site-Characteristic table (tbl_nnss_sit_chr). Records are identified and linked by the unique site number (UnqNoUSGS) and the desired sort order is maintained by the (SrtOrdUSGS) field. Both the UnqNoUSGS and SrtOrdUSGS are maintained in the five Microsoft® Excel® spreadsheet versions of the database. Records are available for download at https://www.sciencebase.gov/mercury/. Records from the lithologic description, rock property, fracture characteristic, and hydraulic property databases require more space than is practical for page-size illustrations. Therefore, examples are shown in figures derived from tables. Locations of both underground and surface sites contained in the NNSS USGS Databases are shown in figure 1.

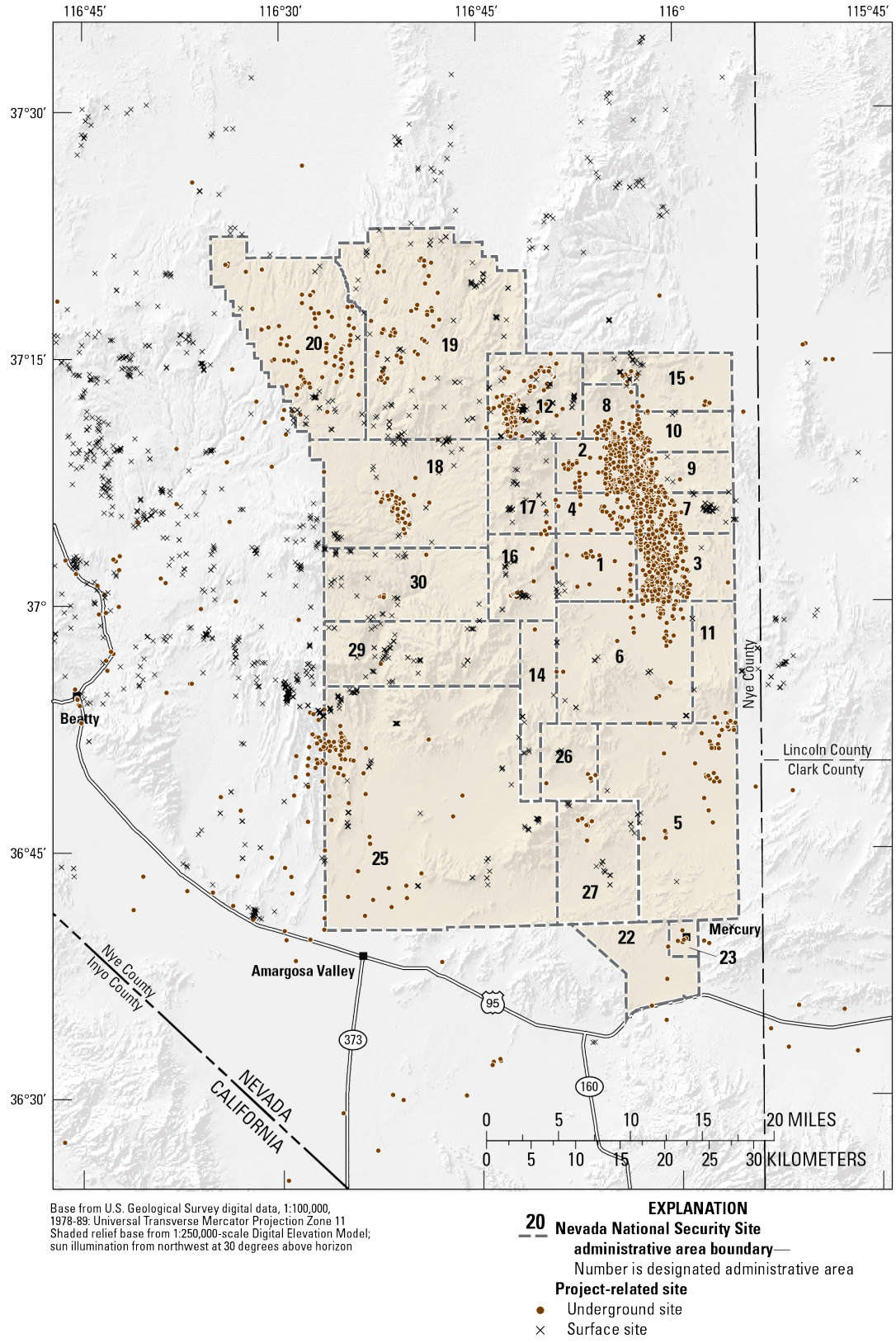


Figure 1. Map showing areal distribution of Nevada National Security Site, U.S. Geological Survey Database sites in vicinity of Nevada National Security Site, Nye County, Nevada.

Rock-Sample Database

The Rock-Sample Database (tbl_nnss_rck_smp) is an inventory of storage locations for historical rock samples housed at the USGS Mercury Core Library and Data Center at Mercury, Nevada; records are available for download at https://www.sciencebase.gov/mercury/. Core samples contained in box 3 from rack 94-U-2 for the U-12n #12 borehole is shown in figure 2*A*. Core in box 99 from pallet 19-018 for the UE-19p borehole is shown in figure 2*B*.

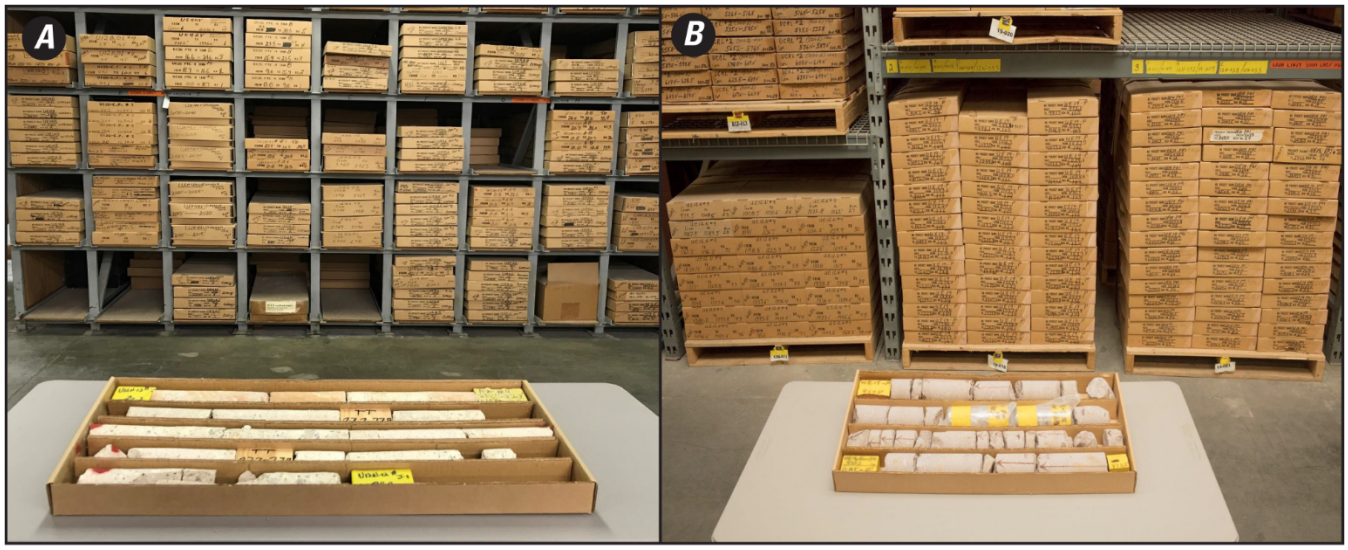
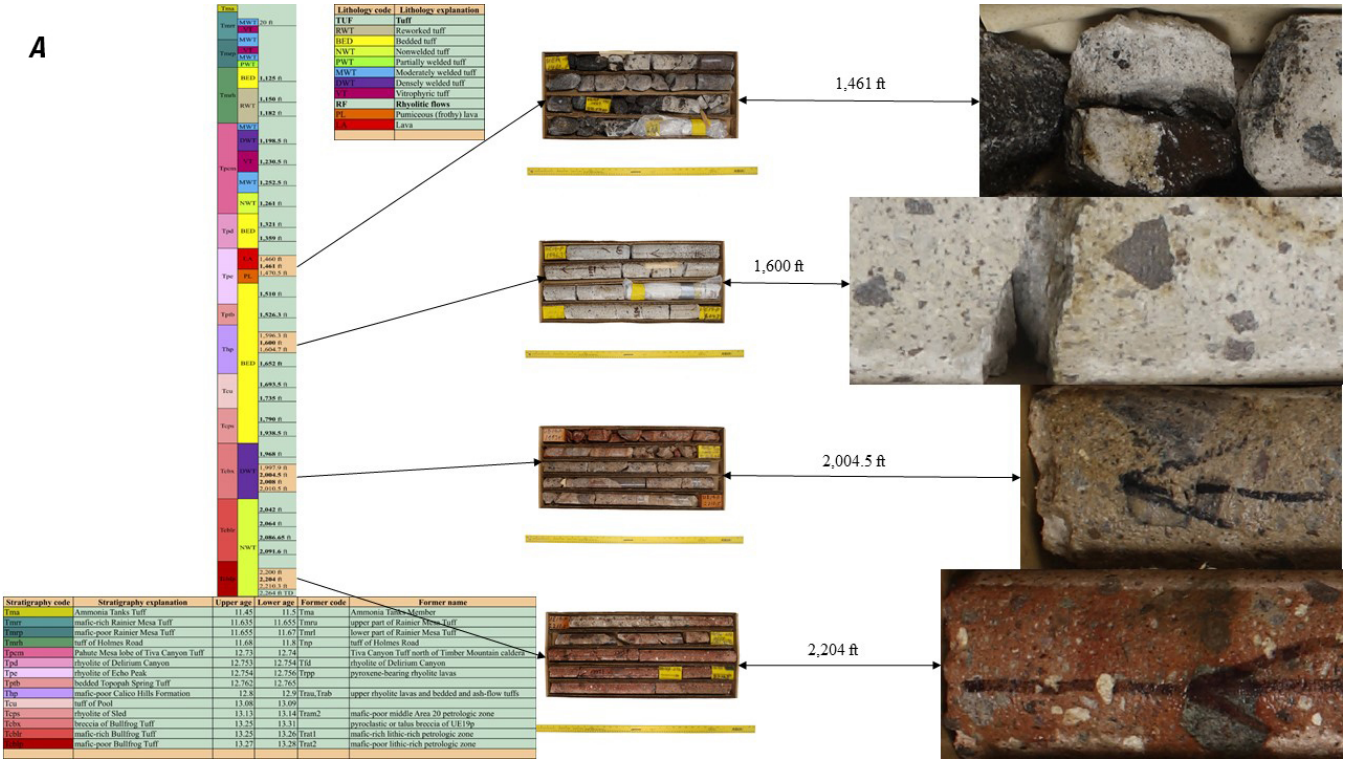


Figure 2. Photographs showing storage locations for rock samples stored at the U.S. Geological Survey Mercury Core Library and Data Center at Nevada National Security Site, Nye County, Nevada. Core samples shown in (*A*) box 3 from rack 94-U-2 for the U-12n#12 borehole and (*B*) box 99 from pallet 19-018 for UE-19p borehole.

Lithologic-Description Database

Historical lithologic interpretations have been compiled into the Lithologic-Description Database table (tbl_nnss_lth_dsc) and records are available for download at https://www.sciencebase.gov/mercury/. A series of 5-character descriptor codes have been developed to summarize text from the written descriptions (LthDsc). These codes (Wood, 2007) consist of the map and (or) stratigraphic unit symbol (MapStratUntSym), original map and (or) stratigraphic unit symbol (OrMapStratUntSym), lithologic group (LthGrp), lithologic description unit (LthDscUnt), lithologic characteristics unit (LthChrUnt), lithologic detailed alterations unit (LthDtlAltUnt), lithologic minor alterations unit (LthMnrAltUnt), and lithologic mineral unit (LthMinUnt).

Rock columns interpreted from lithologic-description records and descriptor codes that correspond to core samples from the UE-19p borehole are shown in figure 3*A*. Rock columns interpreted from lithologic-description records and descriptor codes that correspond with fractures and physical, mechanical, and geochemical properties from the UE-20c borehole are shown in figure 4. Descriptors, analyses, and images all provide important tools for interpreting lithologies.

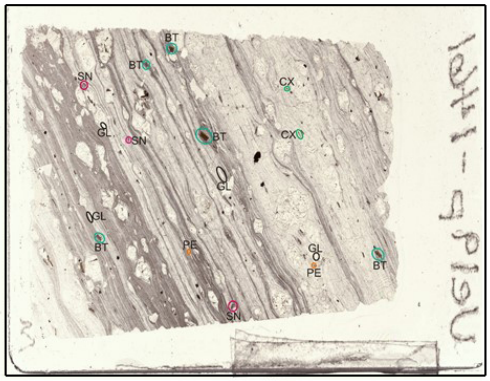


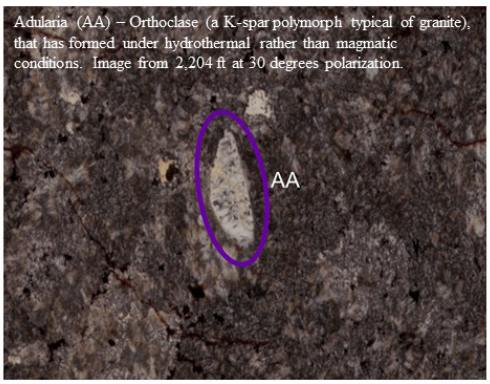
Lithology code	Lithology explanation
TUF	Tuff
RWT	Reworked tuff
BED	Bedded tuff
NWT	Nonwelded tuff
PWT	Partially welded tuff
MWT	Moderately welded tuff
DWT	Densely welded tuff
VT	Vitrophyric tuff
RF	Rhyolitic flows
PL	Pumiceous (frothy) lava
LA	Lava

Stratigraphy code	Stratigraphy explanation	Upper age	Lower age	Former code	Former name
Tma	Ammonia Tanks Tuff	11.45	11.5	Tma	Ammonia Tanks Member
Tmrr	mafic-rich Rainier Mesa Tuff	11.635	11.655	Tmru	upper part of Rainier Mesa Tuff
Tmrp	mafic-poor Rainier Mesa Tuff	11.655	11.67	Tmrl	lower part of Rainier Mesa Tuff
Tmrh	tuff of Holmes Road	11.68	11.8	Tmp	tuff of Holmes Road
Tpcm	Pahute Mesa lobe of Tiva Canyon Tuff	12.73	12.74		Tiva Canyon Tuff north of Timber Mountain caldera
Tpd	rhyolite of Delirium Canyon	12.753	12.754	Tfd	rhyolite of Delirium Canyon
Tpe	rhyolite of Echo Peak	12.754	12.756	Tpp	pyroxene-bearing rhyolite lavas
Tptb	bedded Topopah Spring Tuff	12.762	12.765		
Thp	mafic-poor Calico Hills Formation	12.8	12.9	Trau,Trab	upper rhyolite lavas and bedded and ash-flow tuffs
Tcu	tuff of Pool	13.08	13.09		
Tcps	rhyolite of Sled	13.13	13.14	Tram2	mafic-poor middle Area 20 petrologic zone
Tchx	breccia of Bullfrog Tuff	13.25	13.31		pyroclastic or talus breccia of UE19p
Tchlr	mafic-rich Bullfrog Tuff	13.25	13.26	Tra1	mafic-rich lithic-rich petrologic zone
Tchlp	mafic-poor Bullfrog Tuff	13.27	13.28	Tra2	mafic-poor lithic-rich petrologic zone

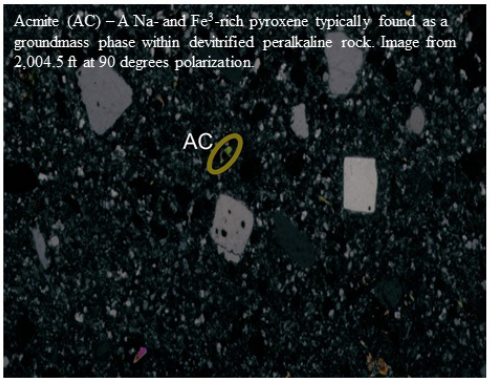
Figure 3. Representation of rock column derived from lithologic records compared with core samples (*A*) and thin sections (*B*–*E*) from the UE-19p borehole. A large format of figure 3 is available for download at https://doi.org/10.3133/ofr20181011.

B

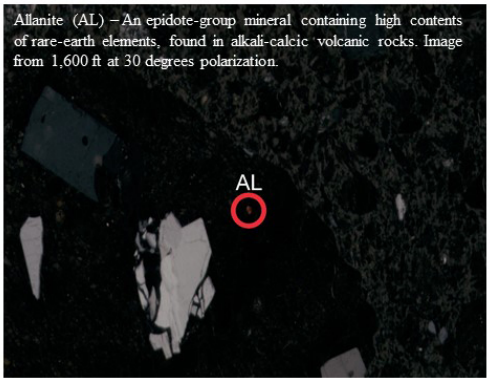




Adularia (AA) – Orthoclase (a K-spar polymorph typical of granite), that has formed under hydrothermal rather than magmatic conditions. Image from 2,204 ft at 30 degrees polarization.

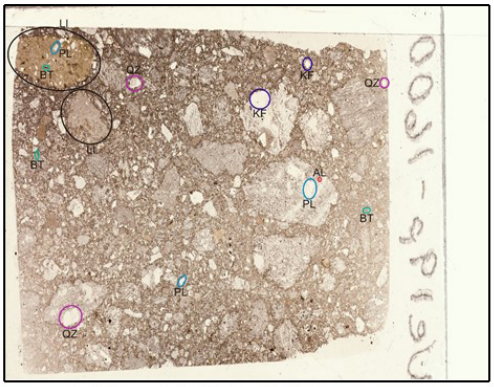


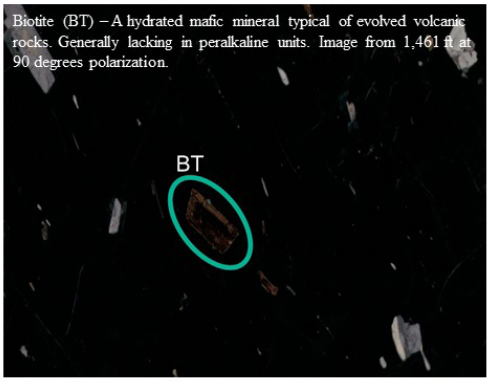
Acmite (AC) – A Na- and Fe^3-rich pyroxene typically found as a groundmass phase within devitrified peralkaline rock. Image from 2,004.5 ft at 90 degrees polarization.



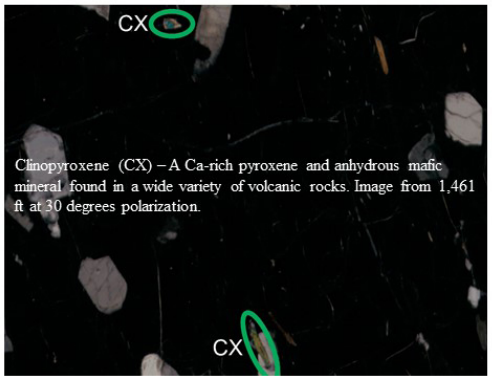
Allanite (AL) – An epidote-group mineral containing high contents of rare-earth elements, found in alkali-calcic volcanic rocks. Image from 1,600 ft at 30 degrees polarization.

C

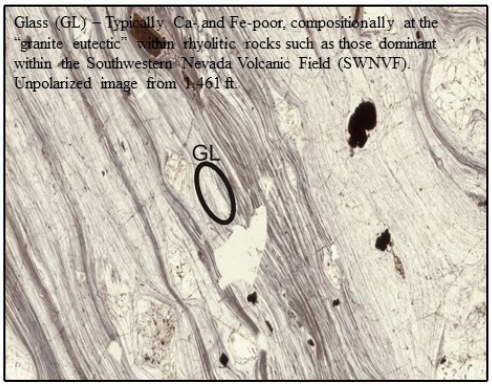




Biotite (BT) – A hydrated mafic mineral typical of evolved volcanic rocks. Generally lacking in peralkaline units. Image from 1,461 ft at 90 degrees polarization.



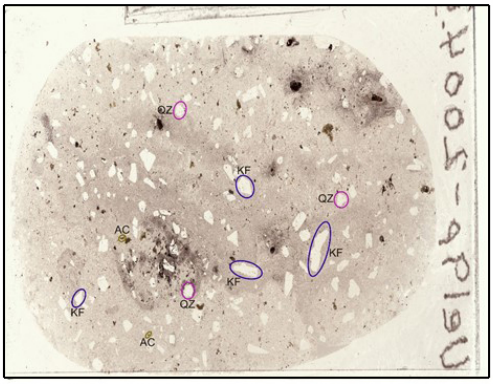
Clinopyroxene (CX) – A Ca-rich pyroxene and anhydrous mafic mineral found in a wide variety of volcanic rocks. Image from 1,461 ft at 30 degrees polarization.

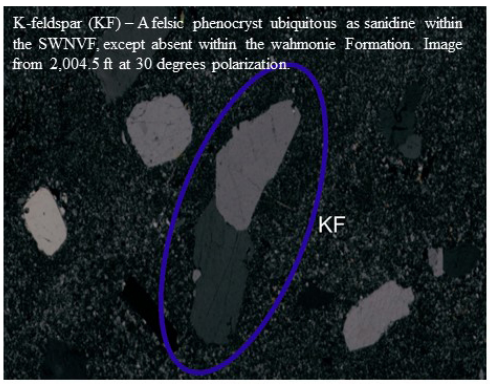


Glass (GL) – Typically Ca- and Fe-poor, compositionally at the "granite eutectic" within rhyolitic rocks such as those dominant within the Southwestern Nevada Volcanic Field (SWNVF). Unpolarized image from 1,461 ft.

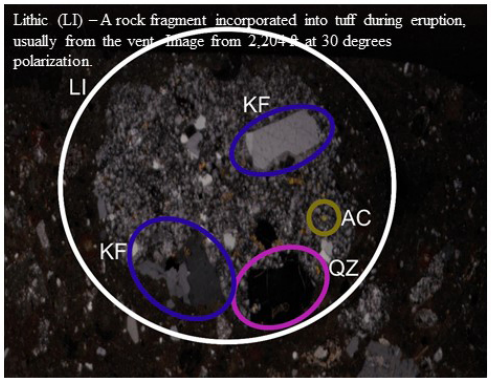
Figure 3.—Continued

D

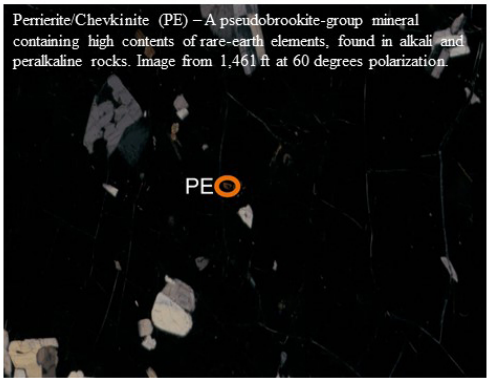




K-feldspar (KF) – A felsic phenocryst ubiquitous as sanidine within the SWNVF, except absent within the wahmonie Formation. Image from 2,004.5 ft at 30 degrees polarization.

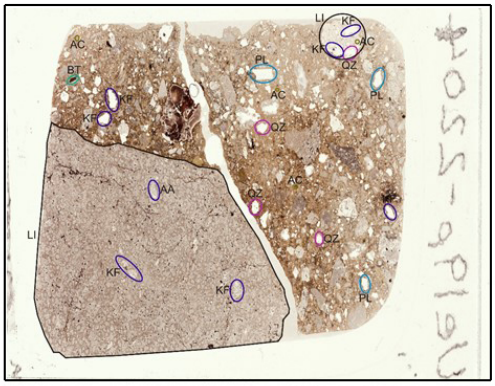


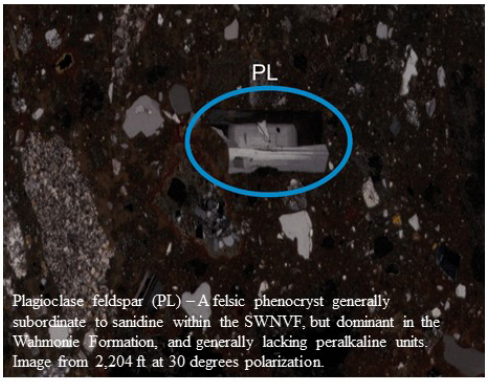
Lithic (LI) – A rock fragment incorporated into tuff during eruption, usually from the vent. Image from 2,204 ft at 30 degrees polarization.



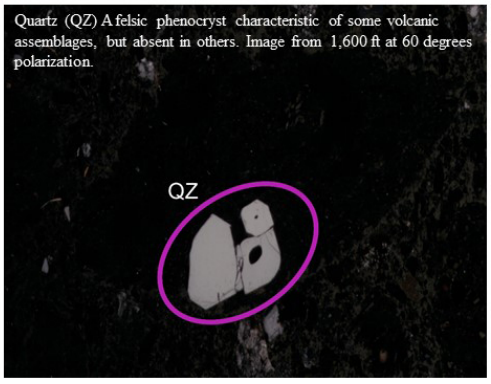
Perrierite/Chevkinite (PE) – A pseudobrookite-group mineral containing high contents of rare-earth elements, found in alkali and peralkaline rocks. Image from 1,461 ft at 60 degrees polarization.

E

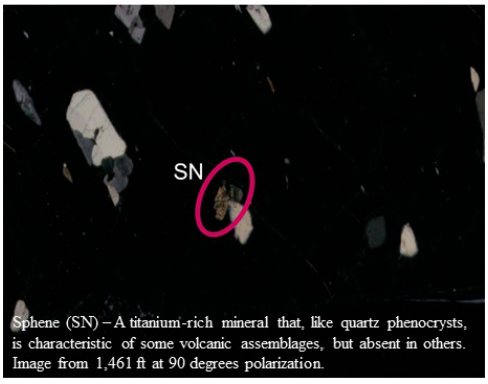




Plagioclase feldspar (PL) – A felsic phenocryst generally subordinate to sanidine within the SWNVF, but dominant in the Wahmonie Formation, and generally lacking peralkaline units. Image from 2,204 ft at 30 degrees polarization.



Quartz (QZ) A felsic phenocryst characteristic of some volcanic assemblages, but absent in others. Image from 1,600 ft at 60 degrees polarization.



Sphene (SN) – A titanium-rich mineral that, like quartz phenocrysts, is characteristic of some volcanic assemblages, but absent in others. Image from 1,461 ft at 90 degrees polarization.

Figure 3..—Continued

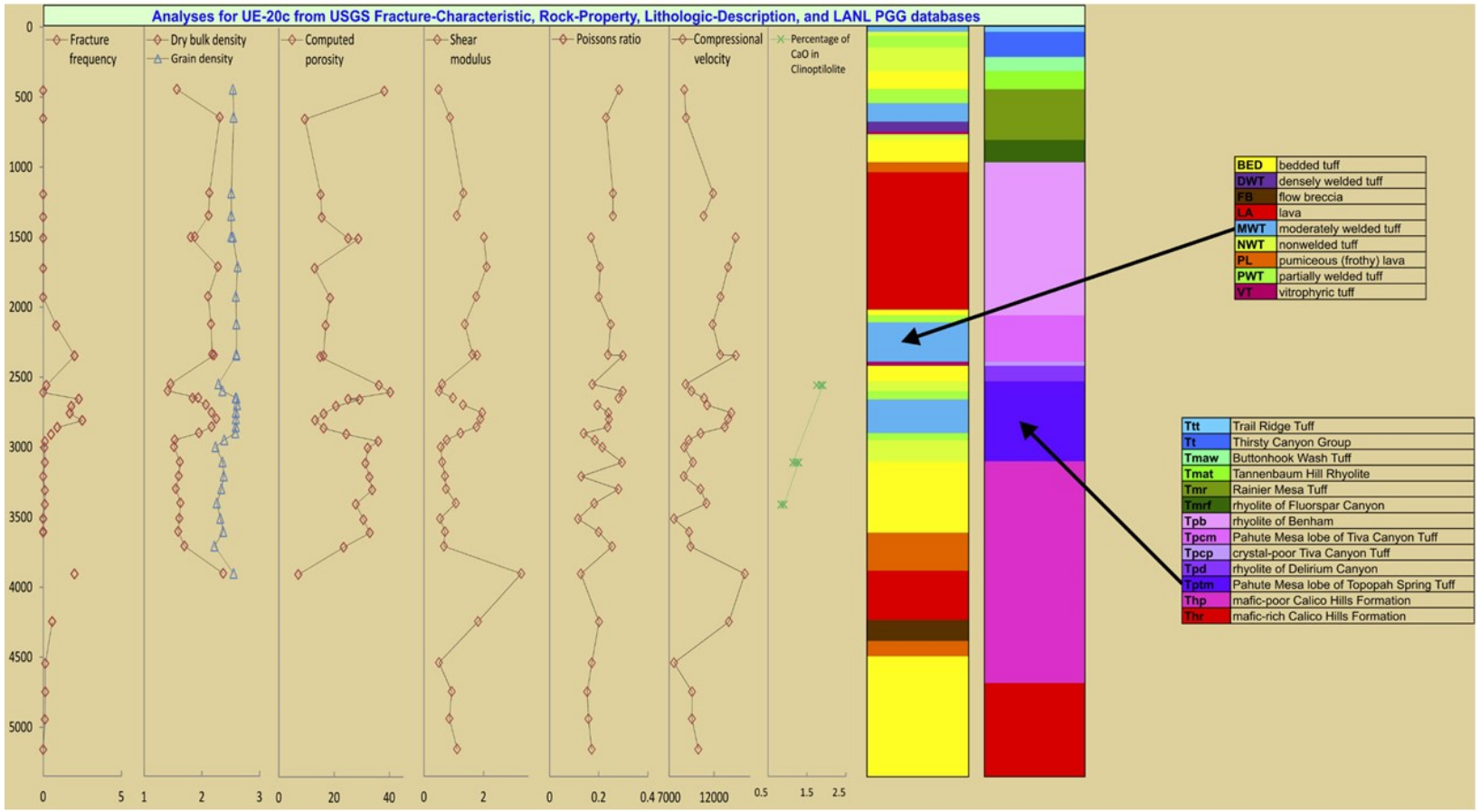


Figure 4. Representation of rock column derived from lithologic records compared with profiles from fracture characteristic, rock property, and geochemical database records for the UE-20c borehole, Nevada National Security Site, Nye County, Nevada. A large format of figure 4 is available for download at https://doi.org/10.3133/ofr20181011.

Rock-Property Database

Historical physical and mechanical property analyses have been compiled into the Rock-Property Database table (tbl_nnss_rck_pty); these records are available for download on ScienceBase. Density, porosity, shear modulus, Poisson's ratio, and compressional velocity analyzed from samples from UE-20c are shown in figure 4.

Fracture-Characteristic Database

Historical fracture records have been compiled into the Fracture-Characteristic Database table (tbl_nnss_fct_chr) and are available for download at https://www.sciencebase.gov/mercury/. Fracture frequencies are shown that correspond to lithologic interpretations for the UE-20c borehole in figure 4.

Hydraulic-Property Database

Historical injection and withdrawal records (mostly packer tests) have been compiled into the Hydraulic-Property Database table (tbl_nnss_hyd_pty) and are available for download at https://www.sciencebase.gov/mercury/. Water-level recovery from swabbing and injection tests in the U-19e borehole is shown in figure 5.

Rock-Sample Images

Historical rock samples (core and cuttings) have been photographed and are available at https://www.sciencebase.gov/mercury/. Core samples are shown that correspond to thin sections and lithologic interpretations for the UE-19c borehole (fig. 3).

Thin-Section Images

Historical thin-section mounts of rock samples have been scanned and are available at https://www.sciencebase.gov/mercury/. Minerals identified from thin-section images are shown, along with polarized versions of the mounts, for the UE-19p borehole in figure 3*B–E*. Polarized images were scanned as a demonstration project for UE-19p. The adjustment of doubled polarizing sheets on thin-section mounts for varying extinction angles is not practical for routine scanning.

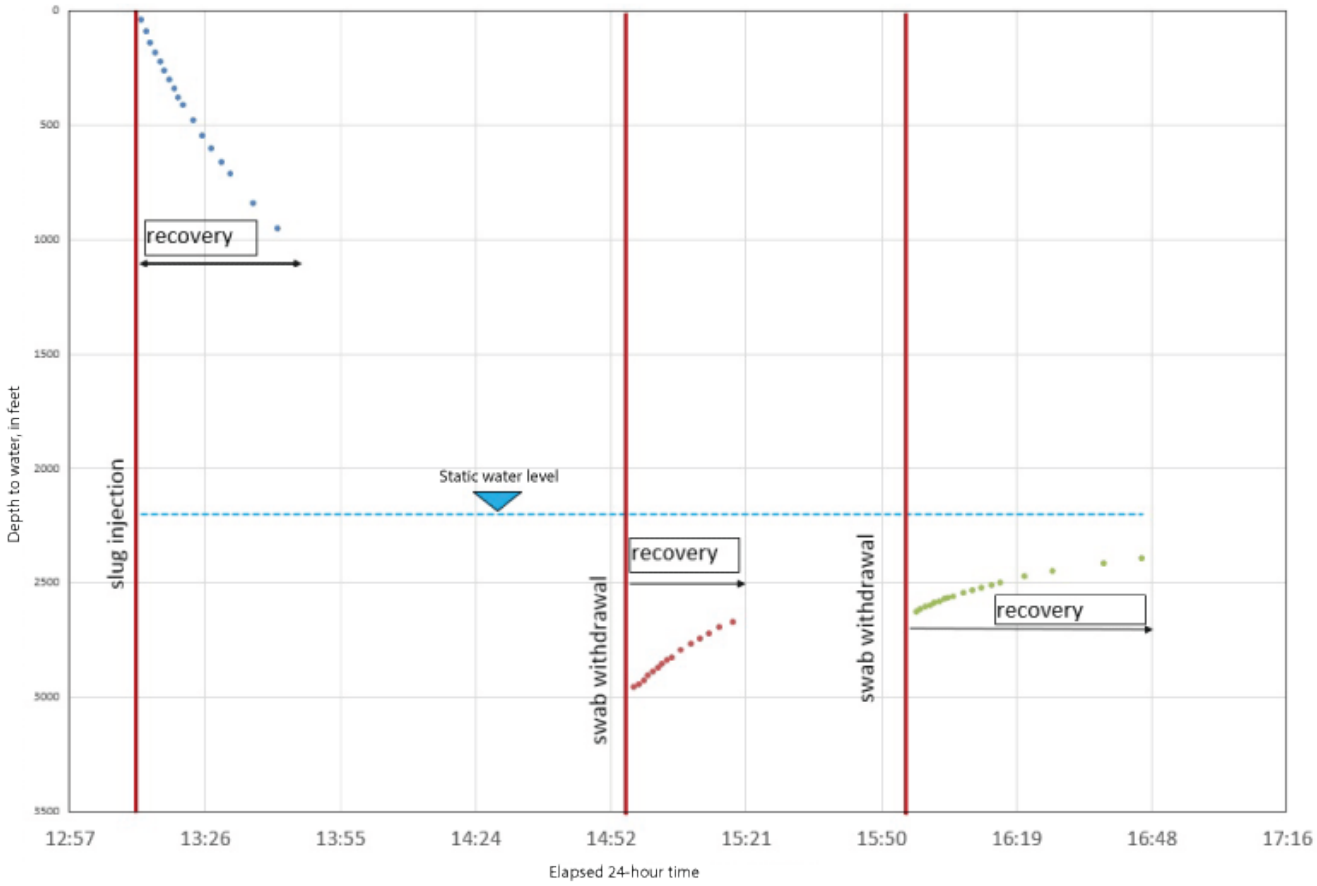


Figure 5. Graph showing water-level recovery from injection and packer tests in the U-19e borehole, Nevada National Security Site, Nye County, Nevada.

Nevada National Security Site Petrographic, Geochemical, and Geophysical (PPG) Database

The NNSS PGG Database is an updated version of the historical records published in Warren and others (2003) and served as Microsoft® Access® tables and records that are available for download at https://www.sciencebase.gov/mercury/. Sites are identified by the location (loc_id) in the table tbl_location. The UnqNoUSGS and SrtOrdUSGS fields have been added to link and sort these data with records in the NNSS USGS Databases tables. Records are further identified by the sample (sam_id) in the table, tbl_sample, and by the sample split (spl_id) in the table, tbl_loc_sam_split. Records from NNSS PGG Database tables require more space than is practical for page-size illustrations. Therefore, examples are shown in figures derived from tables. The locations of both underground and surface sites contained in the NNSS PGG Database are shown in figure 6.

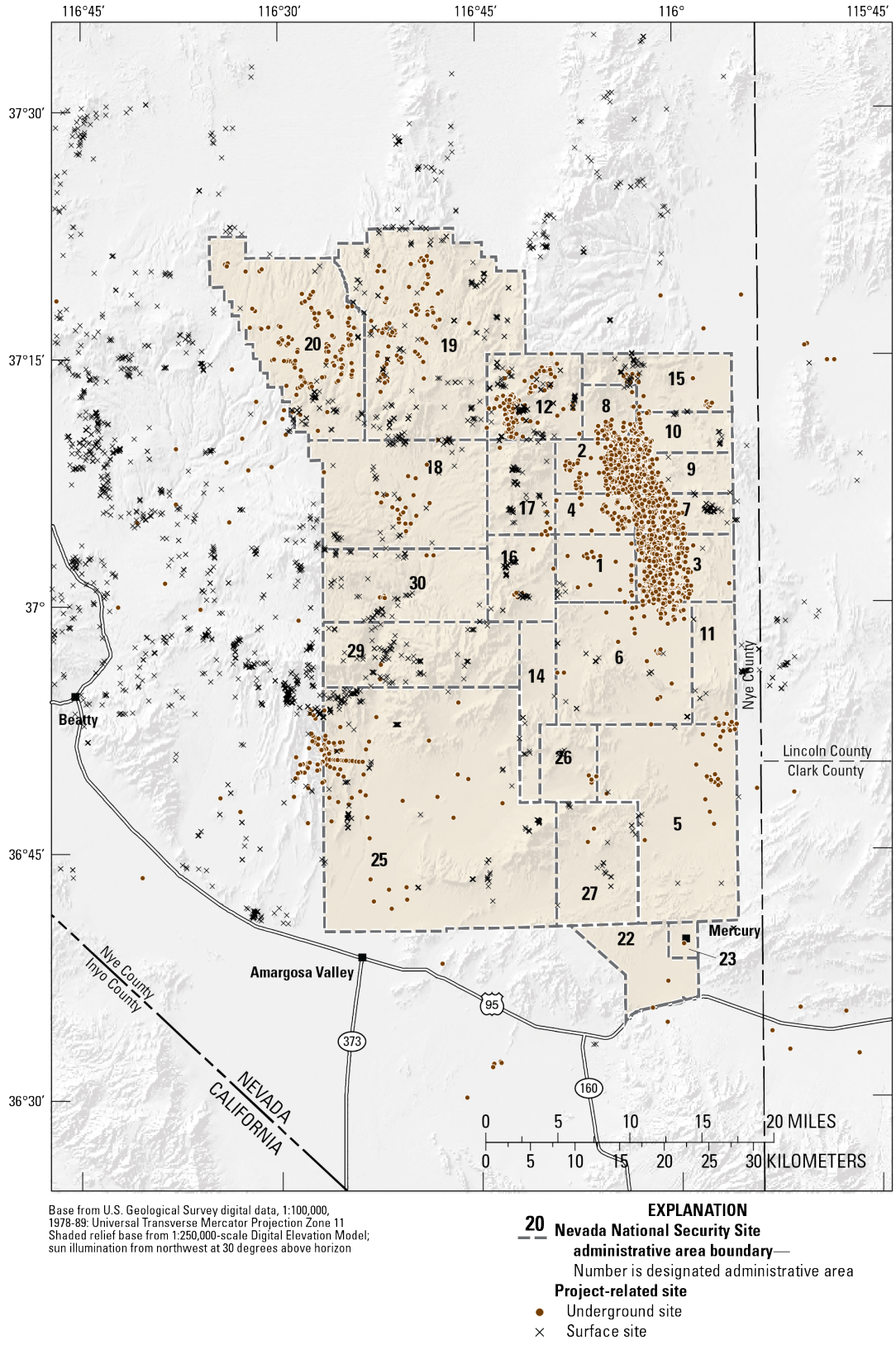


Figure 6. Map showing areal distribution of Nevada National Security Site Petrographic, Geochemical, and Geophysical Database sites in vicinity of Nevada National Security Site, Nye County, Nevada.

Lithic concentrations for six rock units are shown in figure 7. Percentages of calcium oxide in Clinoptilolite for the UE-20c borehole is shown in figure 4.

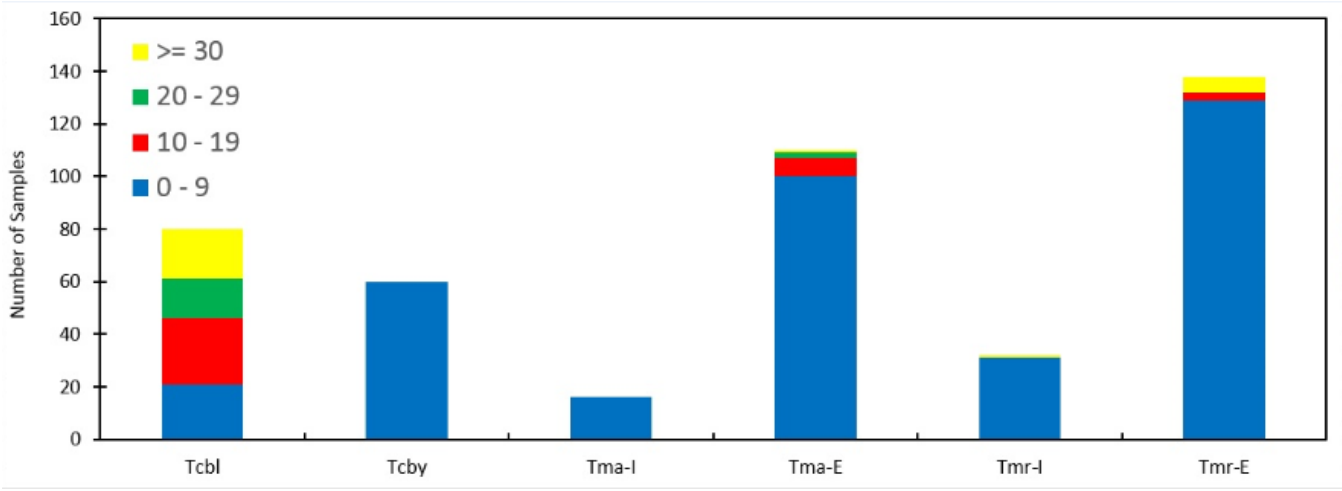


Figure 7. Graph showing lithic contents from six rock units for the UE-20c borehole, Nevada National Security Site, Nye County, Nevada. (Tcbl, lithic-rich Bullfrog Tuff; Tcby, Yucca Mountain lobe of Bullfrog Tuff; Tma-I, Ammonia Tanks Formation–intracaldera; Tma-E, Ammonia Tanks Formation–extracaldera; Tmr-I, Rainier Mesa Formation–intracalderal; Tmr-E, Rainier Mesa Formation–extracaldera)

Summary

Rock samples were collected from drilling and mining operations at the Nevada National Security Site (NNSS) for more than 60 years. Records derived from sample analyses and interpretation are available for public download at the USGS ScienceBase, Mercury Core Library and Data Center Web site (https://www.sciencebase.gov/mercury/). Rock samples have been photographed and thin sections scanned and available for viewing and download at ScienceBase. Example applications were provided from data taken from the lithologic-description, rock-property, rock-sample, fracture-characteristic, and hydraulic-property databases in the combined NNSS USGS Databases and from the USGS Petrographic, Geochemical, and Geophysical Database, as well as from rock-sample and thin-section images.

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