INTRUSIVE BASEMAP OF UTAH

by

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INTRODUCTION

The Intrusive Basemap of Utah is a geodatabase and tabular dataset of mapping, geochemical, and geochronological data from known, surface-exposed igneous intrusive rocks across Utah. The purpose of this database is to provide a central source of data relevant to the study and interpretation of magmatic activity throughout Utah's geologic history. Mapped extents of intrusive units were compiled from various geologic maps created across the state. Geochemical data originates from the unpublished work conducted by Eric Christiansen (Professor, Department of Geological Sciences, Brigham Young University) for the Utah Geological Survey (UGS) circa 2011; this dataset has been refined with current rock sample analyses obtained from the U.S. Geological Survey (USGS) National Geochemical Database (NGDB). The geochronological data, which provide age determinations for the intrusive units, has been sourced from the Utah Geochronology Database (Utah Geological Survey, undated[a]). Although every effort has been made to verify the data against original source material, the data is presented here as-is.

This release of the Intrusive Basemap of Utah incorporates significant updates and expansions from the original data sources. The data includes nearly 1900 square kilometers of mapped intrusive units, over 1800 refined geochemical analyses, and more than 200 geochronological data points. Detailed descriptions of the database fields are provided below. Descriptions are also included in the relevant data files, which are available in the geodatabase and the accompanying appendix containing spreadsheet files.

Important Considerations

Detection Limits

Given that the geochemical data in this compilation is sourced from a variety of studies and laboratories, detection limits can vary between samples for the same element. For samples that were below detection limit for a given element, the value of the detection limit is given in the concentration column and a qualifier of "L" is given in the qualifier column (e.g., for a gold value below a detection limit of 20 ppm the Au_ppm column will give a value of 20, and the Au_q column will give a value of "L"). Values that were above the detection limit are given a qualifier of "G," and where a value was not detected the qualifier is "N." A summary of the qualifiers used is given in Table 1.

Spatial Resolution and Adjusted Locations

Some geochemical and geochronological points in the dataset have coarse spatial resolutions, with certain locations reported to the nearest 0.25 degrees. This level of precision can introduce spatial errors of up to 20–30 km. If a geochemical or geochronological sample was reportedly sourced from an intrusive unit but was located more than 2 km from the nearest mapped intrusive feature, the point was reviewed. Coordinates were reviewed and adjusted if evidence supported a refined location in association with a known intrusive unit (e.g., the Mayflower stock in Park City). Where samples were moved, new attributes—Lat_Updated and Long_Updated—were added. Original coordinates—Lat_Original and Long_Original—remain in the dataset, allowing users to use either the original or adjusted locations. Alternatively, if coordinates appeared robust and the sample association with an intrusive unit appeared valid in a review of the data source, points were left in with a note indicating they had been reviewed. In these cases the intrusive feature associated with the geochemical or geochronological sample was likely too small to have been captured in mapping at the relevant scale for the area.

Metamorphic Rocks

Metamorphic rocks present a particularly complex lithology in relation to intrusive units, especially in areas where the mapped units remain undifferentiated. Certain gneisses, which are either intrusive in origin or suggest an intrusive relationship, are included in the Geologic Units dataset. The decision to include these units is based on the presence of geochemical and geochronological samples that describe these rocks as having intrusive protoliths.

Table 1. *Geochemical qualifier attribute rules.*

L	The element was detected by the technique but at a level below the lower limit of determination for the method. The value of the lower limit of determination is given in the corresponding data field.
G	The element was measured at a concentration greater than the upper determination limit for the method. The upper limit of determination is given in the corresponding data field.
N	The element was not detected at concentrations above the lower limit of determination for the method. The value of the lower limit of determination is given in the corresponding data field.

Geologic Units with a "?"

Geologic units labeled with a "?" are treated as separate features from their counterparts (e.g., Tsps vs Tsps?). Although these units share the same name, age, composition, description, scale, and source, the presence of a "?" indicates that the mapping of these units carries a lower level of confidence. The confidence level is based on the original mapping, with the citation given for each unit in the datasets (see geodatabase).

Unpublished Data

Geologic units from the unpublished west half of the Salina quadrangle, based on the work of Doelling et al. (in preparation), have been included in this report. These units are currently considered preliminary and are subject to change upon final publication of the map. Descriptions, names, locations, and symbols of these units may be updated.

Citations

Citations in the Geologic Units dataset for the geologic maps follow the format of the UGS Geologic Map Portal (Utah Geological Survey, undated[b]). Citations in the Geochemical and Geochronological datasets follow the citation format of the Utah Geological Survey (Carney et al., 2024).

METHODS

Overview

This publication is the first public release of the Intrusive Basemap, featuring several key enhancements and updates from previously developed versions. Polygon boundaries were refined for greater map accuracy, projection errors were corrected and standardized, and geochemical analysis qualifiers were reinstated in the dataset. Additionally, citations and data values were thoroughly reviewed and updated as necessary, with overall quality control significantly improved across all three datasets.

Compiling IBM_UT_GeologicUnits

The Intrusive Basemap of Utah Geologic Units were primarily sourced from previously digitized quadrangles across Utah. Where digitized maps were unavailable, but PDF maps existed, georeferencing and digitization were completed as necessary. The baseline scale for this study was 1:100,000 mapping, however more detailed scales were used in many areas where 1:100,000-scale mapping was not available (Figure 1). For regions without detailed mapping beyond the 1:250,000 scale, Stokes et al. (1961–1963) was used. Intrusive units were identified through name and description filtering. Linear features like dikes were standardized to a 20-meter thickness with rounded edges. Projection discrepancies between maps were resolved, and all mapped units were converted to WGS84. Cambrian unit symbols were modified to use a standard "C" instead of the barred "Є" to improve software compatibility. Citations were normalized, and new data sources were integrated to enhance the dataset's comprehensiveness. Geochemistry and geochronology points without corresponding polygons were reviewed, with updates made either to the point data or to the geologic units to ensure accuracy and consistency. The abbreviation **ND** is used throughout the text columns to indicate "no data." For samples with descriptions that include multiple lithologies, the first listed rock type was assigned to the Rock_Type column.

Compiling IBM_UT_Geochron

Geochronological data sourced from the Utah Geochronology Database (Utah Geological Survey, undated[a]) were standardized to million years, rounded to two decimal places, and coordinates normalized to WGS84. Since the Utah Geochronology Database includes non-intrusive rock types, data filtering was applied using the relationship, unit, and material attributes; those that indicated an intrusive origin were included. Age discrepancies in samples were reviewed and resolved to the original publication values to ensure reliable geochronological information. Additionally, sample citations that had been previously truncated due to character limits were corrected to provide full and accurate references. Samples with no Sample_ID were labeled as "Unnamed sample" and the abbreviation **ND** is used throughout the text columns to indicate "no data." For samples with descriptions that include multiple lithologies, the first listed rock type was assigned to the Rock_Type column.

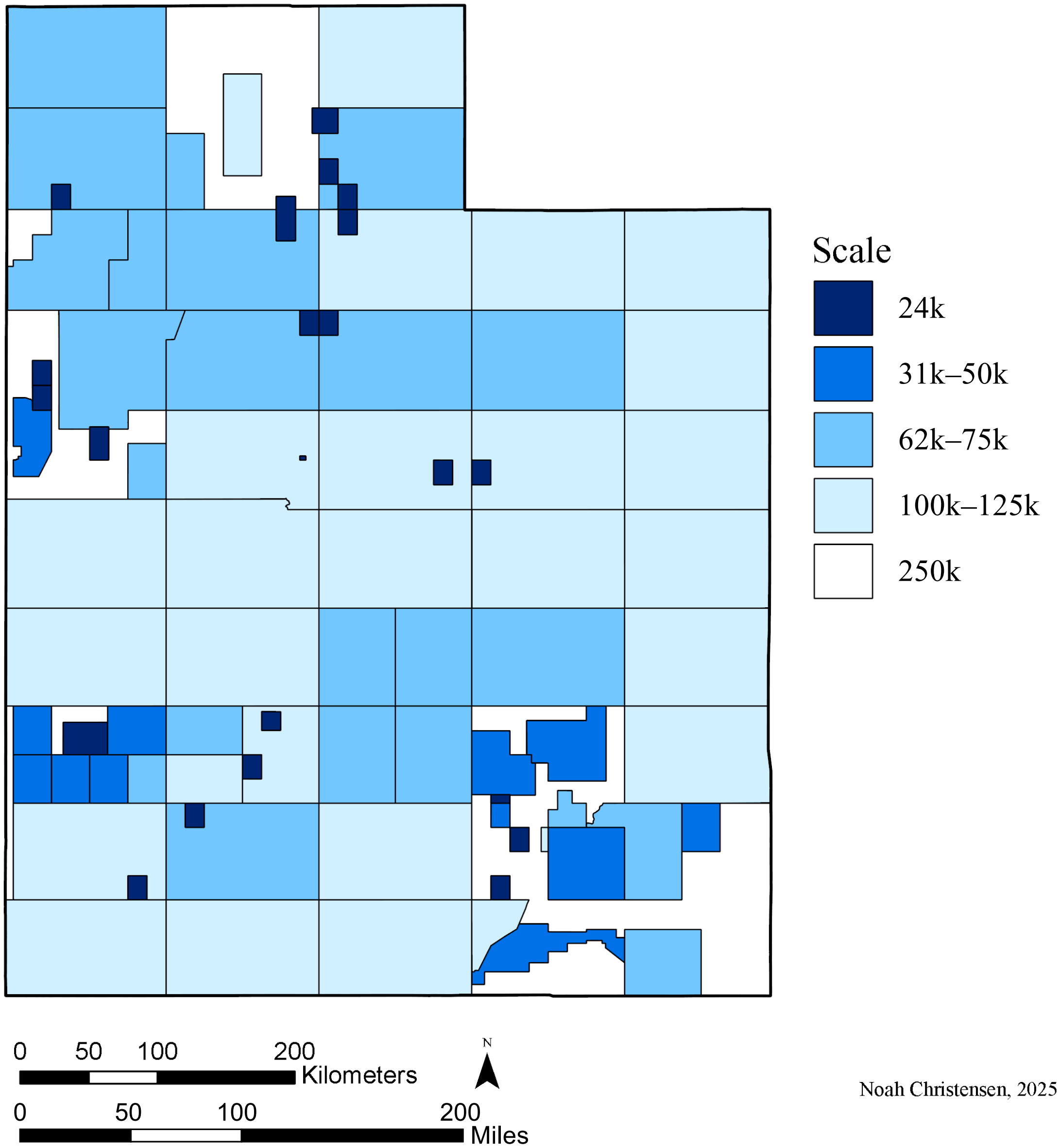

Figure 1. *Map scales for the Intrusive Basemap geologic units across Utah, ranging from 1:24,000 to 1:250,000. The 1:24,000-scale maps overlying coarser resolution maps were included where geochemical or geochronological data indicated intrusive units, but these units were only mapped in the finer resolution scales; typically smaller intrusive features like dikes.*

Compiling IBM_UT_Geochem

In the Geochemistry dataset, geochemical concentrations were standardized to weight percent (wtpct) for compounds and parts per million (ppm) for elements, rounded to two decimal places, and coordinates normalized to WGS84. Due to the compiled data including non-intrusive rock types, data filtering was applied using the emplacement type, rock type, and structural sources attributes; those that indicated an intrusive origin were included. Data harmonization included converting the field_id column from the USGS GCDB into the Sample_ID column and including the Lab_ID column to simplify handling duplicate sample IDs. For samples with multiple analysis values, the maximum value was retained. Detection limits were reintroduced as qualifier attributes for each analysis, following USGS GCDB rules (Table 1). Samples without coordinates were excluded from the dataset. For samples with multiple chemical analysis types in the Method_Chem column, the methods were separated by a semicolon (e.g., ES; INAA). Similarly, for samples with multiple qualifiers due to various chemical analyses on the same sample, their qualifiers were separated by a semicolon (e.g., L; N). The abbreviation **ND** is used throughout the text columns to indicate "no data." For samples with descriptions that include multiple lithologies, the first listed rock type was assigned to the Rock_Type column.

SUGGESTED FUTURE DATA COLLECTION

The Utah Mineral Occurrence System (UMOS) Database (Utah Geological Survey, 2023) was used to identify areas of interest for further geochemical and geochronological data collection relevant to mineral resources, including critical minerals, as a future focus direction for data collection and updates to this database. Areas highlighted below could benefit from additional data collection to improve understanding of Utah's intrusive units and provide meaningful insights into the geologic history and mineral potential of these regions. Regions with significant geological potential were identified by filtering UMOS data based on criteria such as active mining operations, active prospects, medium or larger deposit sizes, and igneous intrusive deposit models. The results were then compared to the coverage of mapping, geochemical, and geochronological data in this publication. These suggested future data collection sites are based on the present dataset. Future versions of this data series will incorporate additional age and geochemical data from existing literature not included in this release of the Intrusive Basemap of Utah.

Utah's intrusive units have sparse geochronological coverage, with only 231 samples in this data series, of which 75% were dated using the less precise K-Ar method. High-precision U-Pb dating is critically underrepresented by just 18 samples. To improve geological understanding of the magmatic history of Utah, more precise geochronological data is essential. Areas for further data collection can be identified based on proximity to important resources and gaps in the current dataset. Conversely, the vast majority of intrusive units have geochemical analyses. Despite the broader geochemical dataset, existing data could still benefit from more comprehensive sampling, particularly across larger surficial exposures and utilizing diverse chemical analysis techniques to cover a broader range of elemental values.

- **Iron Mountain, Pinto Iron Mining District, Iron Springs Mining District, Iron County**: Only two geochemical data points and a single geochronological data point characterize the laccoliths associated with magnetite mineralization in this district. Given the unique provenance of the intrusions and the associated substantial iron production, additional sampling is critical to better characterize its geochemical composition and determine precise ages across the district.
- **Various Mines Northwest of Milford, Beaver County**: This region, which includes a quartz monzonite intrusion, has limited data, with only three geochronological and two geochemical samples available. Expanding sampling efforts here would help fill critical gaps in understanding the geological history and mineralization processes associated with this intrusion.
- **Tintic Mining District, East Tintic Mountains, Utah County:** As one of Utah's largest and most historically significant mining districts, the Tintic district hosts over 100 geochemical data points across various intrusive rocks. However, it is severely lacking in geochronological data, having only two data points in this dataset. Additional dating of the intrusive rocks is needed to correlate the geochemical data with the timing of mineralization events, providing a more comprehensive understanding of this district's geological development.
- **Gold Hill, Gold Hill Mining District, Clifton Mining District, Tooele County:** This area hosts several different intrusive units and has a reasonable number of geochemical (11) and geochronological (8) samples. However, given the complexity of the intrusive units in Gold Hill, further sampling is recommended. Additional geochemical and geochronological data would enhance the assessment of the region's mineral potential and contribute to understanding the geological history of its intrusive rocks.

EXPLANATION OF DATABASE FIELDS

IBM_UT_GeologicUnits

Unit_Symbol Geologic unit symbol. Refer to original geologic map publication (Source) for further details.

Unit_Name Full geologic unit name. Refer to original geologic map publication (Source) for further details.

Age_Strat General age of geologic unit. Refer to original geologic map publication (Source) for further details about dating. Null values indicate no data available.

Rock_Type General rock type.

Composition General rock type and classification.

Description Description of rock unit based on source geologic map. Refer to original geologic map publication (Source) for further details.

Scale Map scale on which intrusive unit polygons are based.

Source Citation for source geologic map used for the entry.

Entered_By Geologist that initially compiled the geologic units.

Updated_By Geologist that updated the compiled geologic units.

Updated_Date Date the geologic unit was updated in the intrusive basemap.

IBM_UT_Geochron

Sample_ID Unique identifier for individual geochronological analyses.

Lat_Original Latitude of sample site in decimal degrees.

Long_Original Longitude of sample site in decimal degrees.

Lat_Updated Moved latitude for samples located more than 2 km from the nearest intrusive feature, the coordinates were reviewed and adjusted if evidence suggested they were associated with a nearby intrusion.

Long_Updated Moved longitude for samples located more than 2 km from the nearest intrusive feature, the coordinates were reviewed and adjusted if evidence suggested they were associated with a nearby intrusion.

Datum Datum for sample site coordinates.

Location_Comment Note on accuracy, geographic markers, and directions associated with sample collection.

Sample_Comment Additional information on the geology of the sample, such as alteration, weathering, texture, or mineralization. Additional context on the geologic setting a sample was taken in, e.g., unit or formation, and in-depth rock type descriptions.

Rock_Type General rock type.

Full_Rock_Type Detailed rock type including composition.

Dating_Material Material used for geochronological analyses.

Dating_Method Method used for geochronological analyses.

Dating_Comment Notes on methodology, accuracy, veracity, and meaning of analytical age.

Age Age determined by geochronological analysis, given in million years before present (Ma).

Age_Error The uncertainty of an age, usually denoted as the ± value given with an age. Represents 1 (68% confidence) or 2 (95% confidence) sigma error (given in the Age_Sigma column where known).

Age_MSWD The Mean Square Weighted Deviation, or statistical “goodness of fit” for the age. Higher MSWD indicates a poorer fit, e.g., ages with MSWD values above 2.5 should be used with caution.

Age_Sigma The level of uncertainty included within the error, i.e., 1 (68% uncertainty included in the error) or 2 (95% uncertainty included in the error) sigma. Null values indicate the uncertainty level of the error was not given in the original data.

Source Citation for the source of the entry.

IBM_UT_Geochem

Sample_ID Unique identifier for individual geochemical analyses.

Lab_ID Secondary unique identifier for individual geochemical analyses.

Lat_Original Latitude of sample site in decimal degrees.

Long_Original Longitude of sample site in decimal degrees.

Lat_Updated Moved latitude for samples located more than 2 km from the nearest intrusive feature, the coordinates were reviewed and adjusted if evidence suggested they were associated with a nearby intrusion.

Long_Updated Moved longitude for samples located more than 2 km from the nearest intrusive feature, the coordinates were reviewed and adjusted if evidence suggested they were associated with a nearby intrusion.

Datum Datum for sample site coordinates.

Location_Comment Note on accuracy, geographic markers, and directions associated with sample collection.

Sample_Comment Additional information on the geology of the sample, such as alteration, weathering, texture, or mineralization. Additional context on the geologic setting a sample was taken in, e.g., unit or formation, and in-depth rock type descriptions.

Rock_Type General rock type.

Full_Rock_Type Detailed rock type including composition.

Method_Chem Analytical method or method type used to obtain the geochemical data.

AAS	Atomic Absorption Spectra
DNAA	Delayed Neutron Activation Analysis
EDXRF	Energy-Dispersive X-Ray Fluorescence
ES	Emission Spectroscopy
FLUOR	Fluorometric
GRAV	Gravimetric
ICPAES	Inductively Coupled Plasma Atomic Emission Spectroscopy
ICPMS	Inductively Coupled Plasma Mass Spectrometry
ID-TIMS	Isotope Dilution Thermal Ionization Mass Spectrometry
INAA	Instrumental Neutron Activation Analysis
ISE	Ion Selective Electrodes
MSC	“Miscellaneous Methods”
SPEC-Mo	Spectrophotometric Molybdenum
TIMS	Thermal Ionization Mass Spectrometry
TITR	Titrimetric
UNK	Analytical methods currently unspecified in the database
WDXRF	Wavelength Dispersive X-Ray Fluorescence
WXRF	Wavelength X-Ray Fluorescence
XRF	X-Ray Fluorescence

Source	Citation for the source of the entry. References specific publications or the USGS NGDB.
Al2O3_wtpct	Concentration of aluminum oxide, given in weight percent (wtpct).
Al2O3_q	Qualifier column for Al2O3_wtpct.
CaO_wtpct	Concentration of calcium oxide, given in weight percent (wtpct).
CaO_q	Qualifier column for CaO_wtpct.
CO2_wtpct	Concentration of carbon dioxide, given in weight percent (wtpct).
CO2_q	Qualifier column for CO2_wtpct.
Fe2O3_wtpct	Concentration of ferric iron oxide, given in weight percent (wtpct).
Fe2O3_q	Qualifier column for Fe2O3_wtpct.
Fe3O4_wtpct	Concentration of iron oxide, given in weight percent (wtpct).
Fe3O4_q	Qualifier column for Fe3O4_wtpct.
FeO_wtpct	Concentration of ferrous iron oxide, given in weight percent (wtpct).
FeO_q	Qualifier column for FeO_wtpct.
K2O_wtpct	Concentration of potassium oxide, given in weight percent (wtpct).
K2O_q	Qualifier column for K2O_wtpct.
LOI_wtpct	Concentration of "Loss on Ignition," a measure of volatile content in a sample. Given in weight percent (wtpct).
LOI_q	Qualifier column for LOI_wtpct.
MgO_wtpct	Concentration of magnesium oxide, given in weight percent (wtpct).
MgO_q	Qualifier column for MgO_wtpct.
MnO_wtpct	Concentration of manganese oxide, given in weight percent (wtpct).
MnO_q	Qualifier column for MnO_wtpct.
Na2O_wtpct	Concentration of sodium oxide, given in weight percent (wtpct).
Na2O_q	Qualifier column for Na2O_wtpct.
NiO_wtpct	Concentration of nickel oxide, given in weight percent (wtpct).
NiO_q	Qualifier column for NiO_wtpct.
P2O5_wtpct	Concentration of phosphorous oxide, given in weight percent (wtpct).
P2O5_q	Qualifier column for P2O5_wtpct.

S_SO4_wtpct	Concentration of sulfate sulfur, given in weight percent (wtpct).
S_SO4_q	Qualifier column for S_SO4_wtpct.
S_Total_wtpct	Concentration of total sulfur, given in weight percent (wtpct).
S_Total_q	Qualifier column for S_Total_wtpct.
SiO2_wtpct	Concentration of silicon oxide, given in weight percent (wtpct).
SiO2_q	Qualifier column for SiO2_wtpct.
TiO2_wtpct	Concentration of titanium oxide, given in weight percent (wtpct).
TiO2_q	Qualifier column for TiO2_wtpct.
Ag_ppm	Concentration of silver, given in parts per million (ppm).
Ag_q	Qualifier column for Ag_ppm.
As_ppm	Concentration of arsenic, given in parts per million (ppm).
As_q	Qualifier column for As_ppm.
Au_ppm	Concentration of gold, given in parts per million (ppm).
Au_q	Qualifier column for Au_ppm.
B_ppm	Concentration of boron, given in parts per million (ppm).
B_q	Qualifier column for B_ppm.
Ba_ppm	Concentration of barium, given in parts per million (ppm).
Ba_q	Qualifier column for Ba_ppm.
Be_ppm	Concentration of beryllium, given in parts per million (ppm).
Be_q	Qualifier column for Be_ppm.
Bi_ppm	Concentration of bismuth, given in parts per million (ppm).
Bi_q	Qualifier column for Bi_ppm.
Br_ppm	Concentration of bromine, given in parts per million (ppm).
Br_q	Qualifier column for Br_ppm.
C_ppm	Concentration of carbon, given in parts per million (ppm).
C_q	Qualifier column for C_ppm.
Cd_ppm	Concentration of cadmium, given in parts per million (ppm).

Cd_q	Qualifier column for Cd_ppm.
Ce_ppm	Concentration of cerium, given in parts per million (ppm).
Ce_q	Qualifier column for Ce_ppm.
Cl_ppm	Concentration of chloride, given in parts per million (ppm).
Cl_q	Qualifier column for Cl_ppm.
Co_ppm	Concentration of cobalt, given in parts per million (ppm).
Co_q	Qualifier column for Co_ppm.
Cr_ppm	Concentration of chromium, given in parts per million (ppm).
Cr_q	Qualifier column for Cr_ppm.
Cs_ppm	Concentration of cesium, given in parts per million (ppm).
Cs_q	Qualifier column for Cs_ppm.
Cu_ppm	Concentration of copper, given in parts per million (ppm).
Cu_q	Qualifier column for Cu_ppm.
Dy_ppm	Concentration of dysprosium, given in parts per million (ppm).
Dy_q	Qualifier column for Dy_ppm.
Er_ppm	Concentration of erbium, given in parts per million (ppm).
Er_q	Qualifier column for Er_ppm.
Eu_ppm	Concentration of europium, given in parts per million (ppm).
Eu_q	Qualifier column for Eu_ppm.
F_ppm	Concentration of fluorine, given in parts per million (ppm).
F_q	Qualifier column for F_ppm.
Ga_ppm	Concentration of gallium, given in parts per million (ppm).
Ga_q	Qualifier column for Ga_ppm.
Gd_ppm	Concentration of gadolinium, given in parts per million (ppm).
Gd_q	Qualifier column for Gd_ppm.
Ge_ppm	Concentration of germanium, given in parts per million (ppm).
Ge_q	Qualifier column for Ge_ppm.

Hf_ppm	Concentration of hafnium, given in parts per million (ppm).
Hf_q	Qualifier column for Hf_ppm.
Hg_ppm	Concentration of mercury, given in parts per million (ppm).
Hg_q	Qualifier column for Hg_ppm.
Ho_ppm	Concentration of holmium, given in parts per million (ppm).
Ho_q	Qualifier column for Ho_ppm.
In_ppm	Concentration of indium, given in parts per million (ppm).
In_q	Qualifier column for In_ppm.
Ir_ppm	Concentration of iridium, given in parts per million (ppm).
Ir_q	Qualifier column for Ir_ppm.
La_ppm	Concentration of lanthanum, given in parts per million (ppm).
La_q	Qualifier column for La_ppm.
Li_ppm	Concentration of lithium, given in parts per million (ppm).
Li_q	Qualifier column for Li_ppm.
Lu_ppm	Concentration of lutetium, given in parts per million (ppm).
Lu_q	Qualifier column for Lu_ppm.
Mo_ppm	Concentration of molybdenum, given in parts per million (ppm).
Mo_q	Qualifier column for Mo_ppm.
Nb_ppm	Concentration of niobium, given in parts per million (ppm).
Nb_q	Qualifier column for Nb_ppm.
Nd_ppm	Concentration of neodymium, given in parts per million (ppm).
Nd_q	Qualifier column for Nd_ppm.
Ni_ppm	Concentration of nickel, given in parts per million (ppm).
Ni_q	Qualifier column for Ni_ppm.
Os_ppm	Concentration of osmium, given in parts per million (ppm).
Os_q	Qualifier column for Os_ppm.
Pb_ppm	Concentration of lead, given in parts per million (ppm).

Pb_q Qualifier column for Pb_ppm.

Pd_ppm Concentration of palladium, given in parts per million (ppm).

Pd_q Qualifier column for Pd_ppm.

Pr_ppm Concentration of praseodymium, given in parts per million (ppm).

Pr_q Qualifier column for Pr_ppm.

Pt_ppm Concentration of platinum, given in parts per million (ppm).

Pt_q Qualifier column for Pt_ppm.

Rb_ppm Concentration of rubidium, given in parts per million (ppm).

Rb_q Qualifier column for Rb_ppm.

Re_ppm Concentration of rhenium, given in parts per million (ppm).

Re_q Qualifier column for Re_ppm.

Rh_ppm Concentration of rhodium, given in parts per million (ppm).

Rh_q Qualifier column for Rh_ppm.

Ru_ppm Concentration of ruthenium, given in parts per million (ppm).

Ru_q Qualifier column for Ru_ppm.

S_ppm Concentration of sulfur, given in parts per million (ppm).

S_q Qualifier column for S_ppm.

Sb_ppm Concentration of antimony, given in parts per million (ppm).

Sb_q Qualifier column for Sb_ppm.

Sc_ppm Concentration of scandium, given in parts per million (ppm).

Sc_q Qualifier column for Sc_ppm.

Se_ppm Concentration of selenium, given in parts per million (ppm).

Se_q Qualifier column for Se_ppm.

Sm_ppm Concentration of samarium, given in parts per million (ppm).

Sm_q Qualifier column for Sm_ppm.

Sn_ppm Concentration of tin, given in parts per million (ppm).

Sn_q Qualifier column for Sn_ppm.

Sr_ppm	Concentration of strontium, given in parts per million (ppm).
Sr_q	Qualifier column for Sr_ppm.
Ta_ppm	Concentration of tantalum, given in parts per million (ppm).
Ta_q	Qualifier column for Ta_ppm.
Tb_ppm	Concentration of terbium, given in parts per million (ppm).
Tb_q	Qualifier column for Tb_ppm.
Te_ppm	Concentration of tellurium, given in parts per million (ppm).
Te_q	Qualifier column for Te_ppm.
Th_ppm	Concentration of thorium, given in parts per million (ppm).
Th_q	Qualifier column for Th_ppm.
Tl_ppm	Concentration of thallium, given in parts per million (ppm).
Tl_q	Qualifier column for Tl_ppm.
Tm_ppm	Concentration of thulium, given in parts per million (ppm).
Tm_q	Qualifier column for Tm_ppm.
U_ppm	Concentration of uranium, given in parts per million (ppm).
U_q	Qualifier column for U_ppm.
V_ppm	Concentration of vanadium, given in parts per million (ppm).
V_q	Qualifier column for V_ppm.
W_ppm	Concentration of tungsten, given in parts per million (ppm).
W_q	Qualifier column for W_ppm.
Y_ppm	Concentration of yttrium, given in parts per million (ppm).
Y_q	Qualifier column for Y_ppm.
Yb_ppm	Concentration of ytterbium, given in parts per million (ppm).
Yb_q	Qualifier column for Tb_ppm.
Zn_ppm	Concentration of zinc, given in parts per million (ppm).
Zn_q	Qualifier column for Zn_ppm.
Zr_ppm	Concentration of zirconium, given in parts per million (ppm).
Zr_q	Qualifier column for Zr_ppm.

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APPENDIX

IBM Utah Tabular Data

https://ugspub.nr.utah.gov/publications/data_series/ds-2/ds-2a.zip

UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources

Intrusive Basemap of Utah 2025

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Scale 1:750,000

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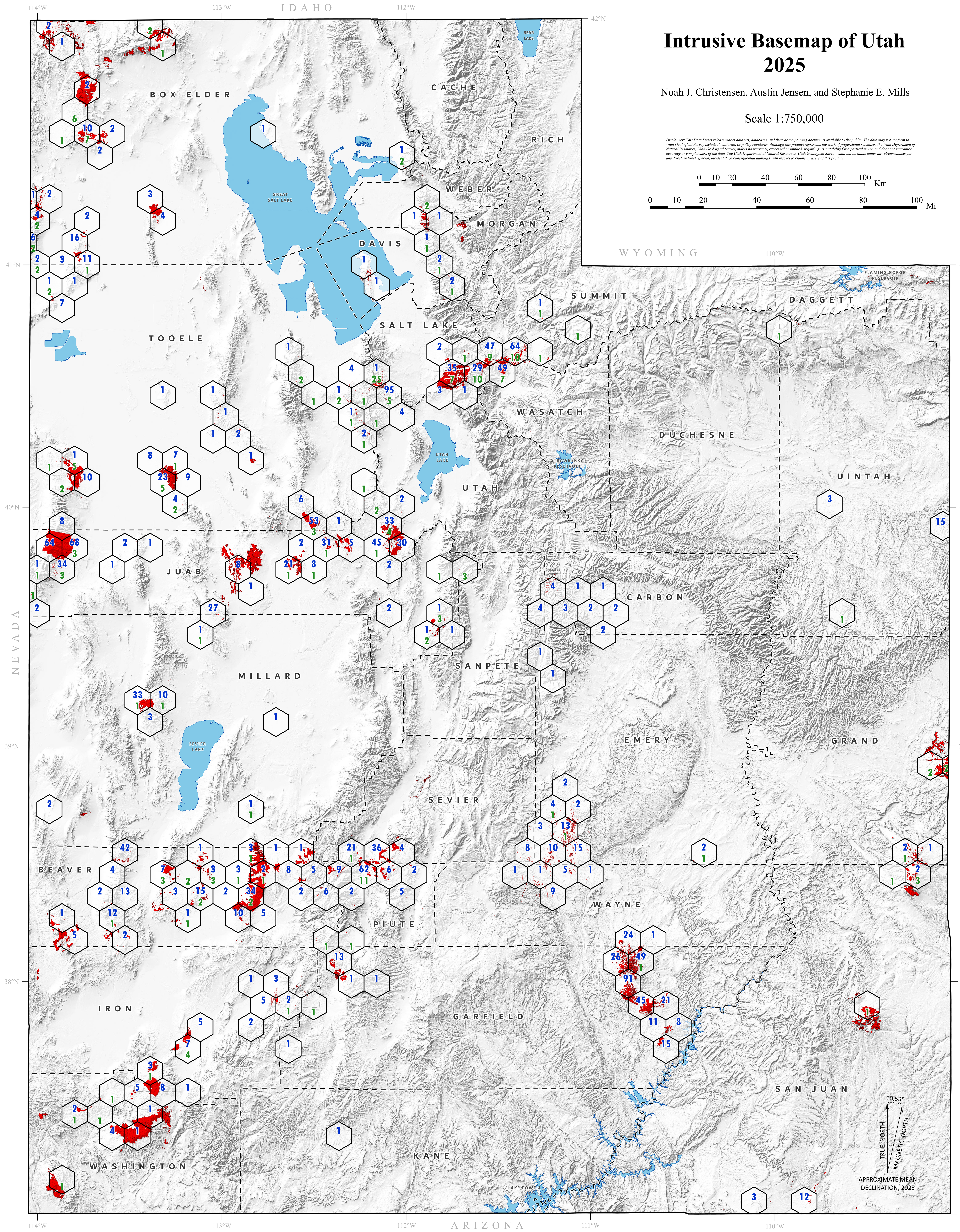
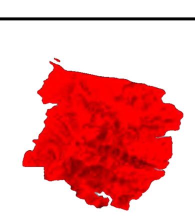
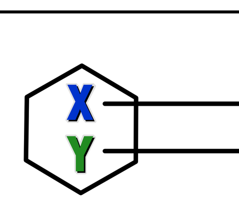



Mapped Intrusive Units



Number of geochemical points in hexagon area*
Number of geochronological points in hexagon area*
*Hexagons cover an area of 200 square kilometers.

Point Data

Base from United States Geological Survey (2021). United States Geological Survey 3D Elevation Program 1 arc-second Digital Elevation Model. Distributed by OpenTopography. https://doi.org/10.5069/G98K778D.
Accessed: 2025-01-30
Projection: Web Mercator (Auxiliary Sphere)
Datum: WGS 1984

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