UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

VEYO QUADRANGLE
UTAH—WASHINGTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

3258 IV NE (MAPLE RIDGE)

3258 I NE (CENTRAL EAST)

3258 IV SE (SUNLOOK)

3258 I SE (SADDLE MOUNTAIN)

3258 I NW (CENTRAL WEST)

3258 II (ST. GEORGE 1:62 500)

Mapped, edited, and published by the Geological Survey

Control by USGS, NOS/NOAA, and U. S. Forest Service

Topography by photogrammetric methods from aerial photographs taken 1972. Field checked 1972

Projection and 10,000-foot grid ticks: Utah coordinate system, south zone (Lambert conformal conic) 1000-metre Universal Transverse Mercator grid ticks, zone 12, shown in blue. 1927 North American datum

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1972 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U. S. Route
State Route

QUADRANGLE LOCATION

VEYO, UTAH
N3715—W11337.5/7.5
1972
AMS 3258 I SW—SERIES V897

Interim Geologic Map of the Veyo Quadrangle, Washington County, Utah

By

Janice M. Higgins

OPEN-FILE REPORT 401
UTAH GEOLOGICAL SURVEY
October 2002

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a division of
UTAH DEPARTMENT OF NATURAL RESOURCES
in cooperation with
U.S. Geological Survey

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Description of Map Units

QUATERNARY

Alluvial deposits

Qal **Stream deposits** – Moderately to well-sorted clay to gravel deposits in large active drainages. Includes terraces up to 10 feet (3 m) above active channels and is 0 to 10 feet (0-3 m) thick.

Qat_{2-3} **Stream-terrace deposits** – Well-rounded, pebble- to cobble-size clasts in a muddy to coarse sand matrix; includes deposits adjacent to and dissected by Qal. Qat2 is 10 to 30 feet (3-9 m) above active channels and is 0 to 20 feet (0-6 m) thick. Qat3 is 30 to 90 feet (9-27 m) above active channels and is typically 0 to 40 feet (0-12 m) thick.

Qag **Alluvial gravel** – Well-rounded, pebble- to cobble-size clasts in a muddy to coarse sand matrix; underlies lava flows in many areas, but only mapped where a gravel pit operation removed the overlying Magotsu Creek flow in the NE1/4 section 11, T. 40 S., R. 17 W.; 0 to 40 feet (0-12 m) thick.

Artificial deposits

Qf **Artificial-fill deposits** – Engineered fill and general borrow material used to create small dams and road foundations; thickness variable.

Eolian deposits

Qes **Eolian-sand deposits** – Well- to very well-sorted, very fine- to medium-grained, well-rounded, usually frosted, mostly quartz sand; derived primarily from the Navajo and Iron Springs Formations; commonly deposited in irregular hummocky mounds on the lee side of ridges; locally forms poorly developed dunes; 0 to 50 feet (0-15 m) thick.

Mass-movement deposits

Qmt **Talus deposits** – Very poorly sorted, angular boulders with minor fine-grained interstitial materials; deposited on and at the base of steep slopes; 0 to 20 feet (0-6 m) thick.

Qms **Landslide deposits** – Very poorly sorted clay- to boulder-size, locally derived debris in chaotic, hummocky mounds; located on steep slopes along the Santa Clara River drainage beneath basalt flows, with basal slip surfaces in the Co-op Creek Limestone Member of the Carmel Formation; thickness highly variable.

Mixed-Environment deposits

Qae **Mixed alluvial and eolian deposits** - Moderately to well-sorted, clay- to sand-sized alluvial sediment that locally includes abundant eolian sand and minor alluvial gravel; minor pedogenic carbonate development; mapped in broad valleys such as Diamond Valley, Santa Clara River valley, and southeast of Veyo Volcano; 0 to 30 feet (0-9 m) thick.

Qac, Qaco

Mixed alluvial and colluvial deposits – Poorly to moderately sorted clay- to boulder-size sediment in minor drainages; gradational with colluvial deposits; Qac deposits are in active drainages and Qaco deposits are dissected by active drainages; includes minor terraces too small to map separately; 0 to 10 feet (0-3 m) thick.

Qea **Mixed eolian and alluvial deposits** - Composed mostly of well-sorted eolian sand locally reworked by alluvial processes; includes minor alluvial deposits; mapped only in the southeast corner of the Veyo quadrangle, near more extensive deposits in the Santa Clara and Washington quadrangles; 0 to 20 feet (0-6 m) thick.

Qmtc **Mixed talus and colluvial deposits** - Conglomerate clasts and sand derived mostly from weathered QTa pediment deposits; deposited on and at the base of slopes eroded into the Muddy Creek and Iron Springs Formations in the northwest corner of the quadrangle; 0 to 10 feet (0-3 m) thick.

Basaltic flows and cinder cones

Divided into 14 flows based on field and geochemical relationships; $^{40}Ar/^{39}Ar$ ages are pending, and no geochemical data are available for several of the flows; thirteen of the flows converge in the Santa Clara River valley to create a complex sequence of flows that show varying degrees of incision; classified using the total alkali vs. silica diagram of LeBas and others (1986).

Qbu **Basaltic flows, undifferentiated –** Used as a map unit for isolated basalt exposures that have not been correlated to adjacent flows.

Qbs, Qbsc

Santa Clara flow and cinder cone – Dark-brownish-black to black subalkaline basalt flow (Qbs) and cinder cone (Qbsc); contains abundant small olivine phenocrysts in an aphanitic groundmass; flows have a very jagged aa surface, and an irridescent sheen is still present on protected surfaces, especially near the cinder cone; cinder cone has a youthful, symmetrical appearance and is partly quarried for cinders; estimated 10,000 to 20,000 years old; flow is typically 0 to 20 feet (0-6 m) thick.

Qbde, Qbdec

Dammeron Valley east flow and cinder cone – Dark-gray trachybasalt flow (Qbde) and cinder cone (Qbdec); contains small olivine phenocrysts in an aphanitic groundmass; cinder cone exhibits only minor rill erosion; flow is 0 to 20 feet (0-6 m) thick, but thickens dramatically near the cinder cone.

Qbrb **River bottom flow –** Dark-gray basaltic trachyandesite; contains some plagioclase phenocrysts and comparatively few olivine phenocrysts compared to nearby flows; preserved as several isolated remnants along the bottom of the Santa Clara

River drainage at the north edge of the map; source is unknown; 0 to 10 feet (0-3 m) thick.

Qbbd **Baker Dam flow –** Dark-gray, dense basalt with abundant olivine phenocrysts; present along the Santa Clara River northeast of Veyo; source is unknown; 0 to 20 feet (0-6 m) thick

Qbpr, Qbprc

Power Plant road flow and cinder cone – Dark-gray basaltic trachyandesite flow (Qbpr) and cinder cone (Qbprc); contains abundant small olivine phenocrysts in an aphanitic groundmass; exposed along the Santa Clara River in the northcentral part of the quadrangle; extensively quarried cinder cone has nearly been removed; flow is 0 to 50 feet (0-15 m) thick.

Qbsr **Subdivision ridge flow –** Dark-gray, fine-grained olivine basalt exposed west of the Santa Clara River at a higher elevation than the Baker Dam flow; source is unknown; 0 to 20 feet (0-6 m) thick.

Qbv_{1-5}, Qbvc

Veyo flows and cinder cone – Dark-gray, fine-grained basaltic trachyandesite flows (Qbv_{1-5}) and cinder cone (Qbvc); contains abundant olivine and sparse plagioclase phenocrysts; flow units are adapted from Embree (1969), with the Qbv_1 flow oldest and Qbv_5 youngest; large, well-preserved cinder cone has only moderately developed rill erosion; flows are 0 to 50 feet (0-15 m) thick, but may thicken dramatically near the cinder cone.

Qbmc, Qbmcc

Magotsu Creek flow and cinder cone – Medium- to dark-gray trachybasalt to basaltic trachyandesite flow (Qbmc) and cinder cone (Qbmcc); coarser grained with fewer olivine phenocrysts than most flows in the quadrangle; contains few plagioclase and rare quartz phenocrysts; cinder cone has been quarried from several pits; flow is 0 to 50 feet (0-15 m) thick.

Qbah **Aqueduct Hill flow –** Dark-gray, dense basaltic trachyandesite; contains small olivine phenocrysts and distinctive aggregates of plagioclase; may have erupted from hill 5082 in section 32, T. 39 S., R. 16 W.; 0 to 50 feet (0-15 m) thick.

Qbsm **Saddle Mountain flow –** Dark-gray, fine-grained basalt to basaltic trachyandesite; contains small olivine and plagioclase phenocrysts; erupted from a source about 1.5 miles (2.5 km) to the east; 0 to 50 feet (0-15 m) thick.

Qbc **Central flow –** Dark-gray, fine-grained olivine basalt with common, small plagioclase and rare quartz phenocrysts; preserved above the subdivision ridge flow in the northeast corner of the quadrangle; source is unknown; 0 to 50 feet (0-15 m) thick.

Qbcw **Central West flow –** Medium-gray, very coarse grained borderline trachyandesite to andesite, dacite, and trachydacite; characterized by large plagiocase phenocrysts; forms hilly, rugged topography and thus varies in thickness; generally 0 to 100 feet (0-30 m) thick; source is unknown.

Qbgw **Granite Wash flow –** Dark-gray, fine-grained basalt to trachybasalt with small olivine phenocrysts; scattered cinder deposits suggest that this flow may have erupted from hill 5672 in the northeast corner of the quadrangle; 0 to 100 feet (0-30 m) thick

Qbdn **Dammeron Valley north flow –** Dark-gray, dense basaltic trachyandesite to trachybasalt; contains common, small olivine and few plagioclase phenocrysts; source unknown; 0 to 50 feet (0-15 m) thick.

QUATERNARY/TERTIARY
Alluvial deposits
QTa **Alluvium –** Erosionally dissected alluvial deposits of silt, sand, gravel, and boulders; mostly coarse to very coarse, medium-gray, well-rounded boulder conglomerate derived from the Bull Valley and Beaver Dam Mountains; forms extensive, caliche-capped pediment surface that slopes southeast to Moody Wash and Magotsu Creek; unconformably overlies Muddy Creek and Iron Springs Formations; thickness varies, up to 150 feet (46 m).

TERTIARY
Muddy Creek Formation
Tm Light-tan to buff, indistinctly bedded, poorly consolidated pebbly sandstone, coarse sandstone, and sparse silty sandstone interbedded with sparse gravel and boulder conglomerate and light-gray to white tuff beds generally less than 3 feet (1 m) thick; basal strata are commonly faulted and slightly tilted to the northwest; thickness varies, up to 300 feet (90 m).

CRETACEOUS
Iron Springs Formation
Ki Interbedded, ledge-forming, mildly calcareous, cross-bedded, fine- to medium-grained sandstone and less resistant, poorly exposed sandstone, siltstone, and mudstone. The formation is variously colored grayish orange, pale yellowish orange, dark yellowish orange, white, and pale reddish brown, and is commonly heavily stained by iron-manganese oxides; liesegang banding is common; deposited in braided-stream and floodplain environments; palynology indicates a Cenomanian through Turonian age for strata near Gunlock (Hintze and others, 1994); 3,500 feet (1,065 m) thick.

Cedar Mountain Formation
Kcm Basal conglomerate clasts as big as 5 inches (15 cm) in diameter and composed mostly of quartzite and chert are well rounded; sandy matrix is orangish gray but weathers dark brownish black; commonly forms caprock and dipslope of cuestas; upper

bentonite bed is poorly exposed in southeast corner of the quadrangle and weathers to form a moderate-red “popcorn” soil; 0 to 100 feet (0-30 m) thick.

JURASSIC

Carmel Formation

Jcx **Crystal Creek Member** – Slope-forming, interbedded, generally thin-bedded, pale- to moderate-reddish-brown mudstone, siltstone, very fine-grained sandstone, and gypsum; poorly exposed in the southeast corner of the quadrangle; thickens eastward in adjoining quadrangles and is only locally preserved beneath the K-1 unconformity; 0 to 20 feet (0-6 m) thick.

Jccu **Upper Co-op Creek Limestone Member** – Thin interbeds of mudstone, siltstone, and limestone, with some very fine- to fine-grained sandstone; weathers to distinctly darker yellowish-brown hues than lower part of member; forms steep ledgy slopes; abundantly fossiliferous with *Pentacrinus* sp. columnals, bivalves, mollusks, and local oyster coquina; thickness varies from 120 to 190 feet (37-58 m).

Jccl **Lower Co-op Creek Limestone Member** – Laterally variable sequence of interbedded, generally thin-bedded, mudstone, siltstone, limestone, gypsum, and very fine- to fine-grained sandstone; weathers to a pale yellowish gray; forms steep ledgy slopes; abundantly fossiliferous with *Pentacrinus* sp. columnals, bivalves, mollusks; 220 feet (67 m) thick.

Temple Cap Formation

Jts **Sinawava Member –** Interbedded, moderate-reddish-brown mudstone, siltstone, very fine-grained silty sandstone, and lesser bedded and nodular gypsum; very poorly exposed, but forms red and gray slope that weathers to soft, gypsiferous soil; contains numerous thin greenish-gray mudstone (altered volcanic ash) beds; 360 feet (110 m) thick.

Navajo Sandstone

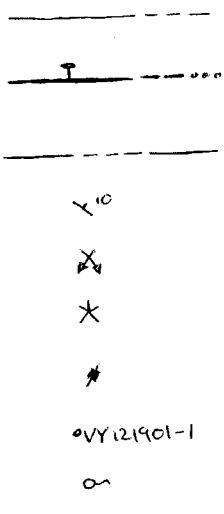
Jn Pale to moderate-reddish-brown, cross-bedded, poorly to moderately well-cemented, well-rounded, fine- to medium-grained, frosted quartz sandstone; strongly jointed; forms cliff; about 2,500 feet (760 m) thick, but only upper 1,800 feet (550 m) exposed in the quadrangle.

REFERENCES

Embree, G.F., 1969, Lateral and vertical variations in a Quaternary basalt flow – petrography and chemistry of the Gunlock flow, southwestern Utah: Provo, Utah, Brigham Young University Geology Studies, v. 17, part 1, p. 67-115.

Hintze, L.F., Anderson, R.E., and Embree, G.F., 1994, Geologic map of the Motoqua and Gunlock quadrangles, Washington County, Utah: U.S. Geological Survey Miscellaneous Invesigations Series Map I-2427, 7 p., scale 1:24,000.

Map Symbols



Contact, dashed where approximately located

Normal fault, dashed where approximately located, dotted where concealed, bar and ball on down-dropped side

Major joint

Strike and dip of inclined bedding

Pit, g = sand and gravel, c = cinders

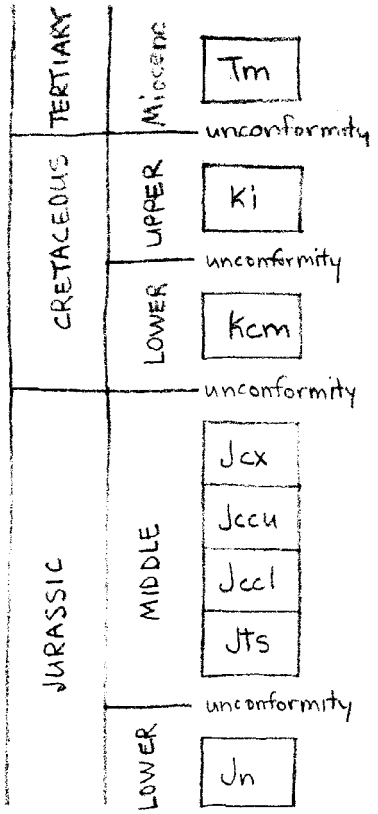
Cinder cone

Strike of near-vertical joint

Sample location and number

Spring

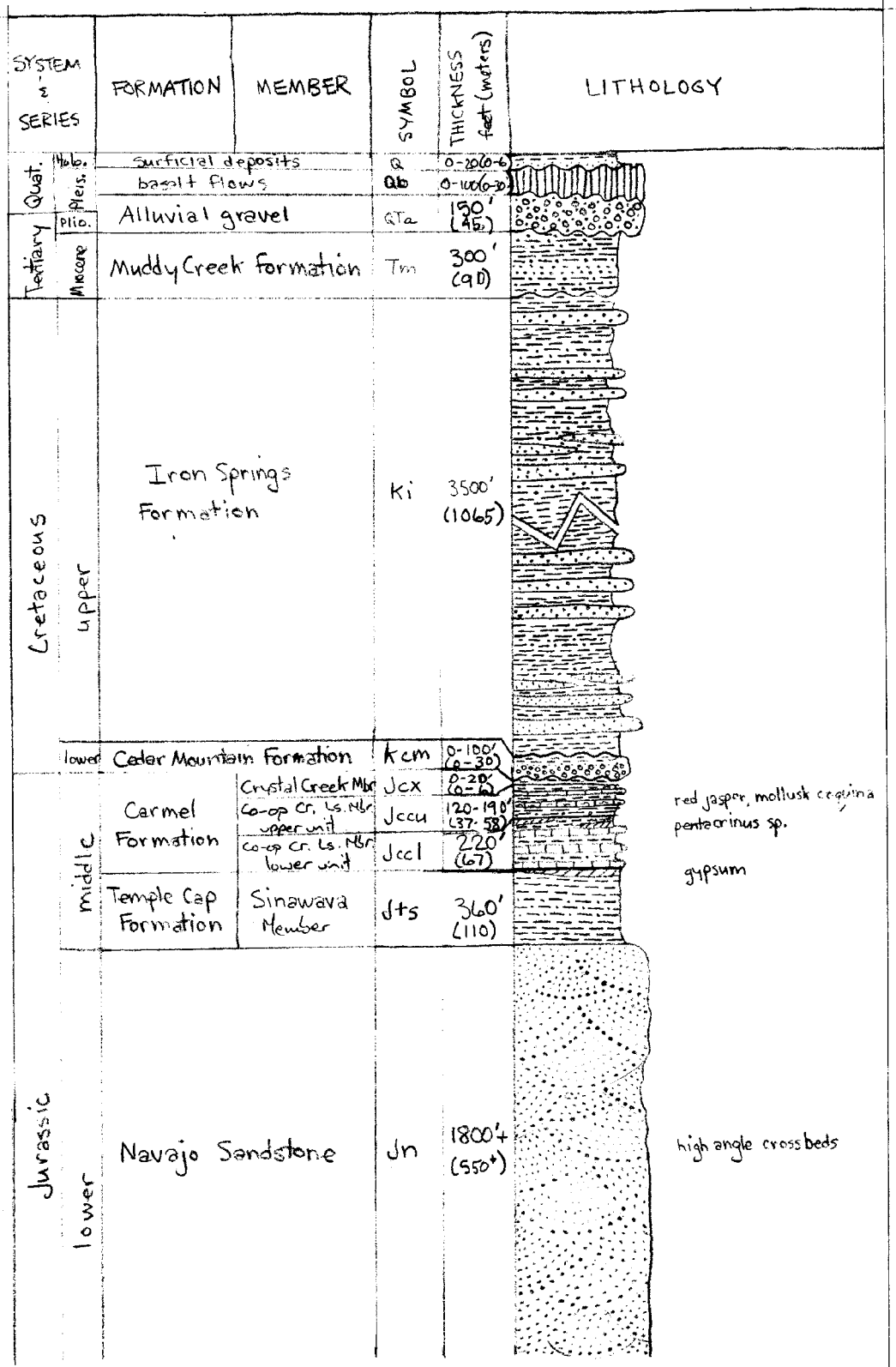
CORRELATION OF BEDROCK UNITS



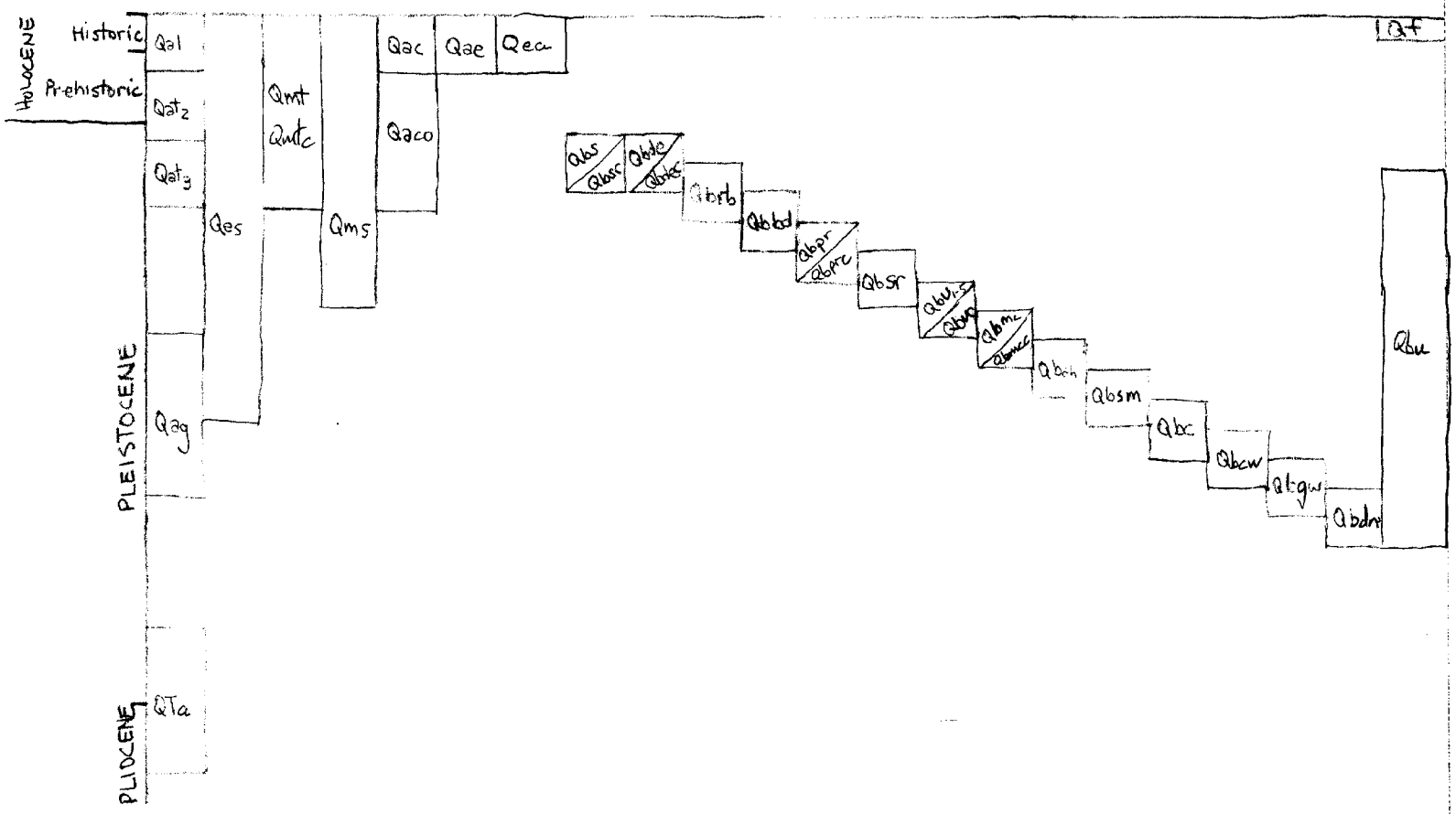
Veyo Quadrangle

J.M. Higgins

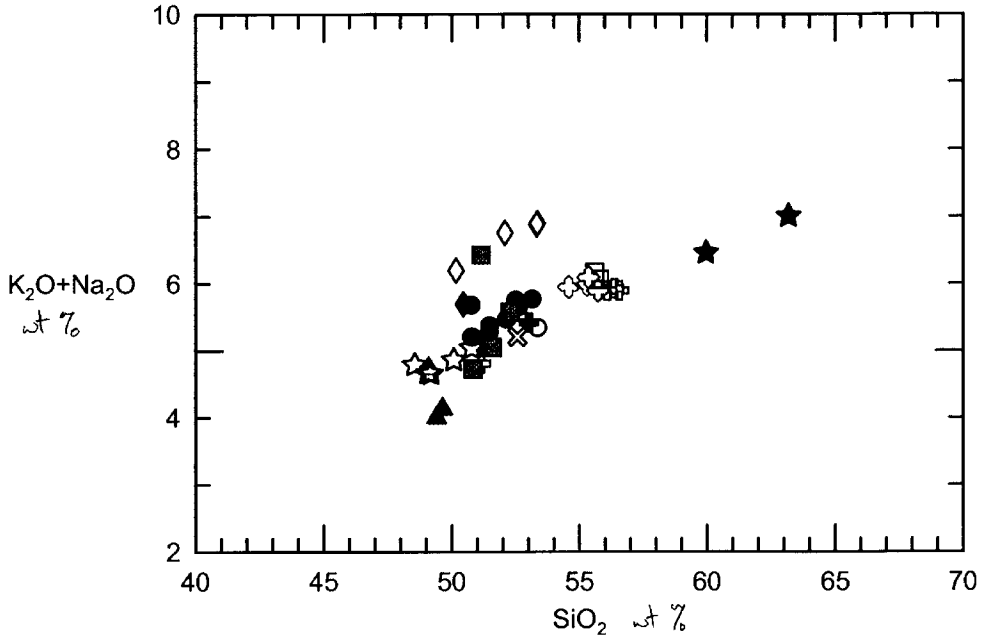
Veyo - J.M. Higgins



Veyo - J.M. Higgins

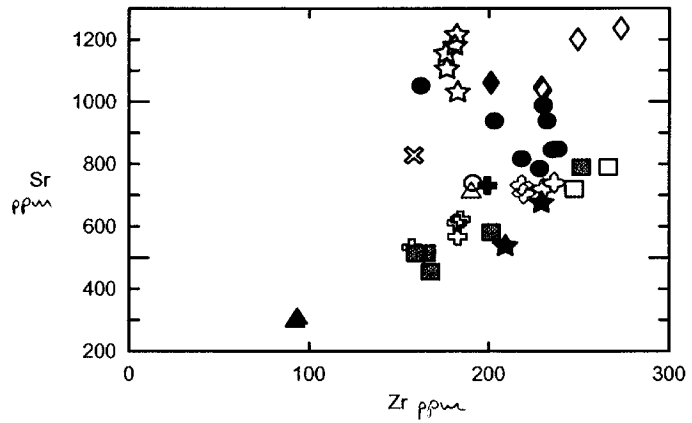


Total Alkali vs. Silica and Variation Diagrams
for Basaltic Flows of the Veyo Quadrangle



Qbs
Qbde
Qbrb
Qbpr
Qbv4
Qbv3
Qbv2
Qbv1
Qbmc
Qbah
Qbsm
Qbcw
Qbgw
Qbdn

See Description of Map Units for abbreviations.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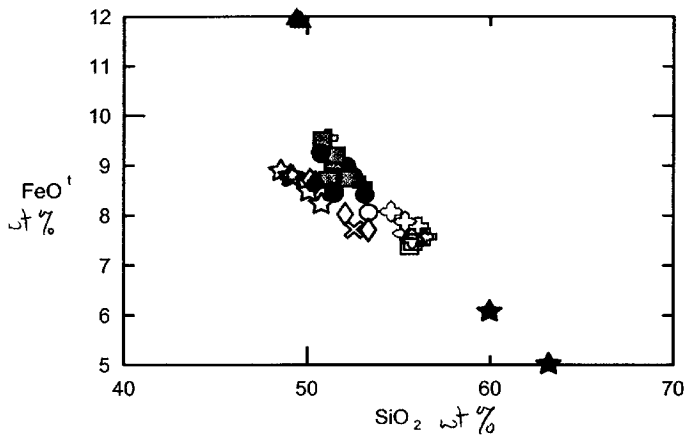
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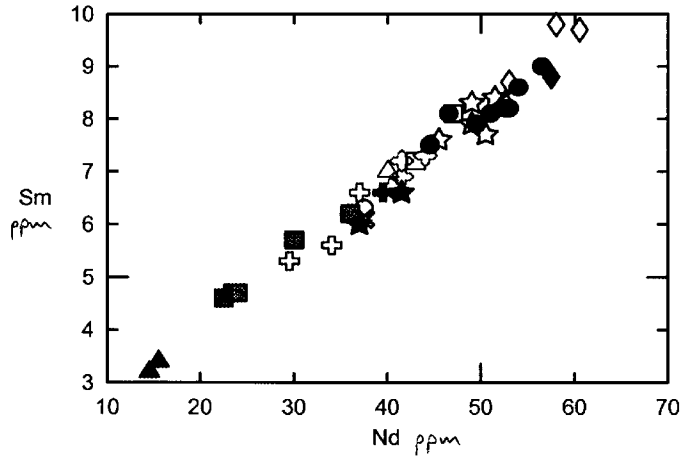
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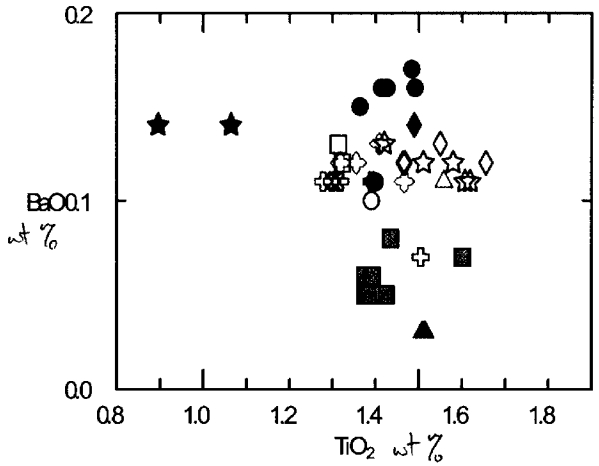
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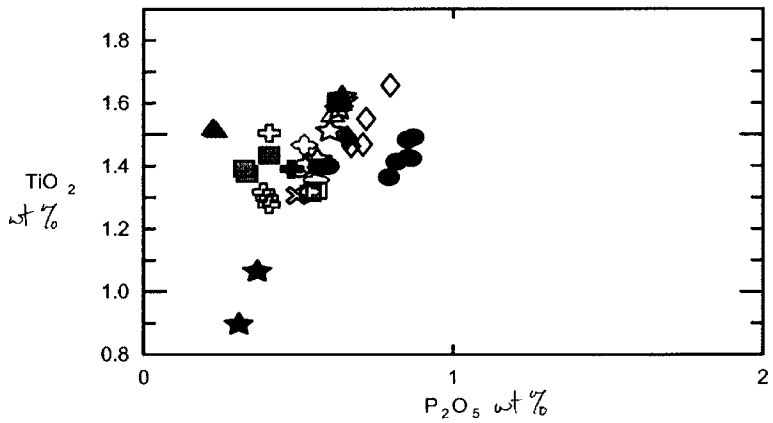
1.8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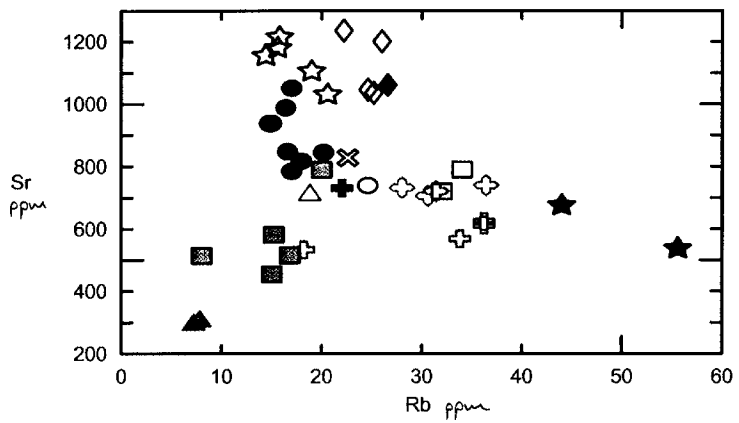
2
P2O5 wt %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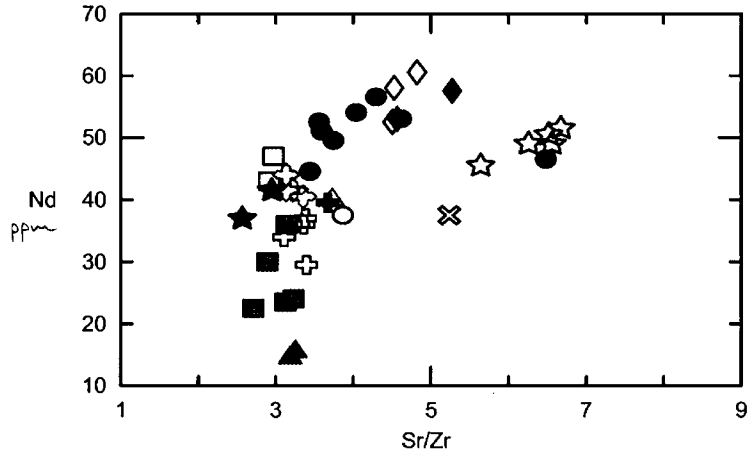
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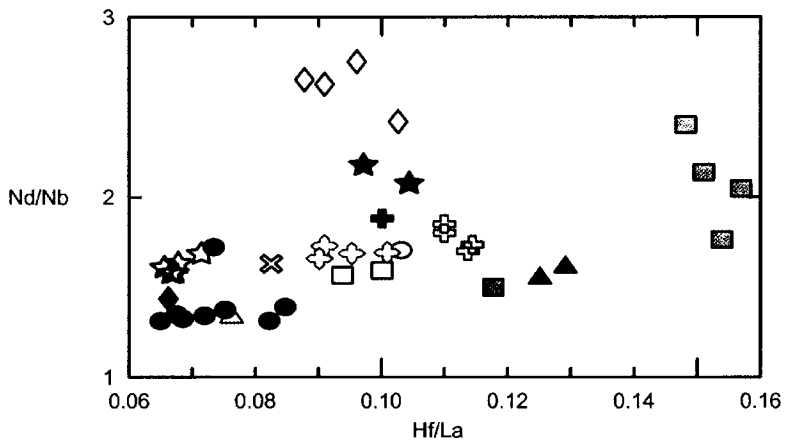
9
Sr/Zr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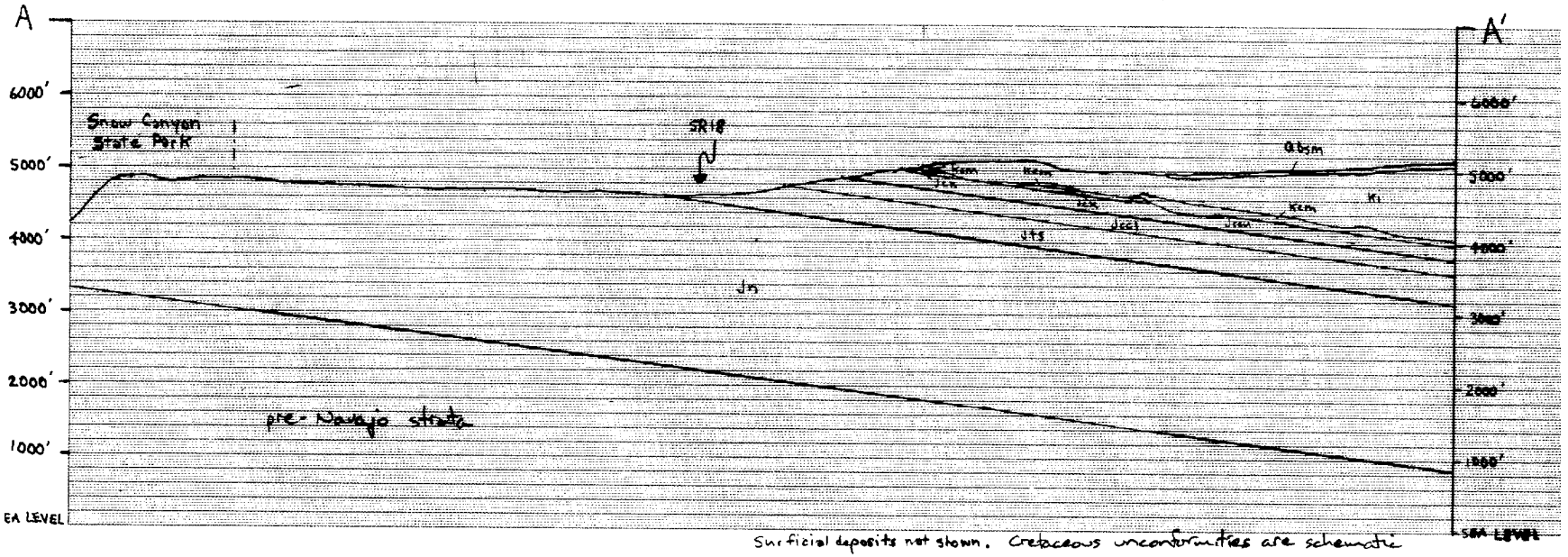
0.14
0.16
Hf/La

Collector	Longitude	Latitude	Flow	7.5' Quadrangle	Sample No.	Collected	Jcode	Kcode	Lcode	Al2O3	BaO	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O
Higgins and Willis	113.625	37.258	Qbs	Saddle Mountain	SM2202	8/3/2001	3	2		15.01	0.03	8.46	0.03	13	0.63	8.4	0.2	3.43
Higgins and Biek	113.744	37.279	Qbv1	Veyo	VY11702-2	1/17/2002	3	18		17.06	0.13	6.67	0.01	8.58	1.97	4.32	0.12	4
Higgins and Biek	113.724	37.316	Qbmc	Veyo	VY11702-3	1/17/2002	3	8		16.45	0.16	8.02	0.02	10.15	1.33	6.86	0.17	4.27
Higgins and Biek	113.722	37.314	Qbv2	Veyo	VY11702-4	1/17/2002	3	17		16.91	0.11	7.18	0.01	8.82	1.86	4.68	0.13	3.98
Higgins and Biek	113.701	37.359	Qbmc	Veyo	VY11702-5	1/17/2002	3	8		16.3	0.11	8.09	0.04	9.34	1.45	7.88	0.15	3.77
Higgins and Biek	113.698	37.358	Qbmc	Veyo	VY11702-6	1/17/2002	3	8		16.35	0.11	8.06	0.04	9.24	1.46	7.71	0.15	3.84
Higgins and Biek	113.650	37.372	Qbrb	Veyo	VY11702-7	1/17/2002	3	14		16.95	0.11	7.65	0.02	9.44	1.66	5.9	0.14	3.68
Higgins and Biek	113.650	37.372	Qbgw	Veyo	VY11702-8	1/17/2002	3	11		16.41	0.13	9.77	0.03	8.95	1.39	6.9	0.13	3.54
Higgins and Biek	113.680	37.326	Qbdn	Veyo	VY11702-9	1/17/2002	3	5		15.87	0.13	7.33	0.03	8.81	2.24	7.18	0.1	4.43
Higgins and Biek	113.631	37.367	Qbgw	Veyo	VY11802-1	1/18/2002	3	11		17.3	0.11	10.51	0.01	9.71	1.18	6.91	0.13	3.52
Higgins and Biek	113.635	37.368	Qbgw	Veyo	VY11802-3	1/18/2002	3	11		16.72	0.12	10.01	0.01	9.24	1.3	6.9	0.13	3.46
Higgins and Biek	113.642	37.368	Qbgw	Veyo	VY11802-4	1/18/2002	3	11		17.02	0.11	10.36	0.01	9.56	1.23	6.88	0.13	3.33
Higgins and Biek	113.643	37.368	Qbgw	Veyo	VY11802-5	1/18/2002	3	11		17.25	0.12	10.31	0.02	9.57	1.22	6.81	0.13	3.35
Higgins and Biek	113.645	37.368	Qbgw	Veyo	VY11802-6	1/18/2002	3	11		16.9	0.11	10.13	0.03	9.64	1.26	7.38	0.13	3.39
Higgins and Biek	113.672	37.371	Qbcw	Veyo	VY11802-7	1/18/2002	3	12		16.16	0.14	5.82	0.01	6.6	2.71	3.37	0.11	3.6
Higgins and Biek	113.722	37.287	Qbv3	Veyo	VY121901-1	12/19/2001	3	7		16.64	0.1	8.7	0.01	8.7	1.6	4.99	0.13	3.59
Higgins and Biek	113.743	37.286	Qbv2	Veyo	VY121901-2	12/19/2001	3	17		16.38	0.12	7.3	0.01	8.21	2	4.42	0.13	3.78
Higgins and Biek	113.744	37.282	Qbv1	Veyo	VY121901-3	12/19/2001	3	18		16.91	0.12	6.87	0.01	8.19	2.03	4.51	0.12	3.74
Higgins and Biek	113.748	37.290	Qbmc	Veyo	VY121901-4	12/19/2001	3	8		16.69	0.16	7.67	0.03	9.84	1.37	6.05	0.16	4.01
Higgins and Biek	113.761	37.281	Qbmc	Gunlock	VY121901-5	12/19/2001	3	8		16.96	0.16	7.48	0.02	9.61	1.49	5.92	0.15	4.11
Higgins and Biek	113.720	37.325	Qbmc	Veyo	VY121901-6	12/19/2001	3	8		16.68	0.17	7.49	0.02	9.62	1.48	5.81	0.16	4.18
Higgins and Biek	113.683	37.319	Qbv4	Veyo	VY121901-7	12/19/2001	3	3		16.89	0.13	6.64	0.01	8.16	2.05	4.69	0.12	3.91
Higgins and Biek	113.630	37.252	Qbs	Veyo	VY122001-1	12/20/2001	3	2		15.22	0.03	8.59	0.03	13.12	0.62	8.5	0.2	3.33
Higgins and Biek	113.649	37.295	Qbsm	Veyo	VY122001-2	12/20/2001	3	4		16.91	0.07	6.93	0.03	9.57	1.76	7.1	0.14	4.59
Higgins and Biek	113.640	37.312	Qbsm	Veyo	VY122001-3	12/20/2001	3	4		17.15	0.06	8.19	0.03	9.92	1.18	6.62	0.16	3.78
Higgins and Biek	113.648	37.309	Qbde	Veyo	VY122001-4	12/20/2001	3	6		15.17	0.14	8.7	0.05	9.5	1.75	8.6	0.13	3.87
Higgins and Biek	113.645	37.328	Qbsm	Veyo	VY122001-5	12/20/2001	3	4		16.85	0.08	7.36	0.03	9.55	1.47	6.67	0.15	4.01
Higgins and Biek	113.651	37.336	Qbdn	Veyo	VY122001-6	12/20/2001	3	5		15.85	0.12	7.48	0.04	9.47	2.05	8.32	0.11	4.01
Higgins and Biek	113.646	37.342	Qbsm	Veyo	VY122001-7	12/20/2001	3	4		16.02	0.05	8	0.04	10.12	1.23	7.9	0.16	3.76
Higgins and Biek	113.659	37.343	Qbsm	Veyo	VY122001-8	12/20/2001	3	4		16.15	0.06	8.08	0.05	10.41	1.01	8.28	0.17	3.64
Higgins and Biek	113.686	37.310	Qbv4	Veyo	VY122001-9	12/20/2001	3	3		17.08	0.12	6.6	0.01	8.07	2.2	4.71	0.12	3.87
Higgins and Willis	113.693	37.333	Qbpr	Veyo	VY8301-1	8/3/2001	3	13		16.24	0.11	6.79	0.01	8.31	2.06	4.76	0.13	3.76
Higgins and Willis	113.666	37.324	Qbdn	Veyo	VY8301-10	8/3/2001	3	5		15.73	0.12	7.04	0.03	8.43	2.31	6.59	0.1	4.46
Higgins and Willis	113.693	37.333	Qbpr	Veyo	VY8301-2	8/3/2001	3	13		16.19	0.11	6.77	0.01	8.23	2.02	4.75	0.12	3.78
Higgins and Willis	113.670	37.348	Qbpr	Veyo	VY8301-3	8/3/2001	3	13		16.14	0.11	6.79	0.02	8.48	2.21	4.88	0.13	3.56
Higgins and Willis	113.672	37.350	Qbah	Veyo	VY8301-4	8/3/2001	3	15		16.51	0.11	9.17	0.03	8.47	1.54	6.49	0.13	3.6
Higgins and Willis	113.676	37.347	Qbpr	Veyo	VY8301-5	8/3/2001	3	13		16.88	0.07	8.72	0.02	10.45	1.14	6.3	0.16	3.59
Higgins and Willis	113.662	37.372	Qbcw	Veyo	VY8301-6	8/3/2001	3	12		15.46	0.14	4.91	0.01	5.42	3.18	2.43	0.09	3.62
Higgins and Willis	113.686	37.367	Qbmc	Veyo	VY8301-7	8/3/2001	3	8		16.7	0.15	7.5	0.02	9.19	1.57	5.64	0.15	4.1
Higgins and Willis	113.678	37.363	Qbmc	Veyo	VY8301-8	8/3/2001	3	8		16.7	0.16	8.16	0.03	10.06	1.26	6.89	0.16	3.85
Higgins and Willis	113.668	37.323	Qbdn	Veyo	VY8301-9	8/3/2001	3	5		15.59	0.12	6.97	0.04	8.35	2.3	6.42	0.1	4.42

Major oxide and trace element analyses of samples from basalt flows in the Veyo quadrangle.
Sample locations shown on geologic map.

P2O5	SiO2	SrO	TiO2	LOI	TOTAL	Ba	Ce	Cr	Cs	Co	Cu	Dy	Er	Eu	Gd	Ga	Hf	Ho	La	Pb	Lu
0.22	48.83	0.03	1.49	<0.01	99.76	226	30		<0.1	47.5	60	3.5	1.8	1	3.9	19	2	0.7	15.5	5	0.2
0.52	54.25	0.09	1.38	0.37	99.47	1275	115		0.5	26	60	5.2	2.7	2	6.8	21	6	1	59.5	25	0.4
0.86	50.06	0.11	1.47	<0.01	99.94	1705	148.5		0.1	30.5	40	5.4	2.9	2.3	7.6	20	5	1	77	15	0.4
0.51	53.63	0.09	1.44	0.05	99.4	1095	103		0.4	24.5	40	4.8	2.5	1.8	6	20	5	1	52.5	15	0.3
0.56	50.91	0.08	1.38	<0.01	99.96	1220	112.5		0.1	36.5	45	5.1	3.1	2.1	6.4	20	5	1	59	15	0.4
0.59	50.8	0.08	1.38	<0.01	99.81	1200	106		0.1	34	35	4.8	2.5	2.2	6.7	20	4	0.8	54.5	15	0.3
0.47	52.28	0.08	1.37	<0.01	99.75	1090	100.5		0.1	33	40	5.1	2.6	1.9	6.3	21	5	0.9	50	10	0.4
0.55	49.69	0.11	1.39	0.62	99.61	1255	114.5		0.2	32.5	50	4.4	2.4	2	6.4	21	4	0.9	56	10	0.3
0.71	51.45	0.14	1.53	<0.01	99.95	1330	138.5		0.1	33	35	5.4	2.6	2.5	7.8	18	6	1	62.5	10	0.4
0.63	47.7	0.13	1.59	0.04	99.47	1305	125.5		0.3	34.5	50	5.1	2.5	2.2	7.3	22	4	1	61	10	0.3
0.59	49.08	0.12	1.48	0.63	99.79	1245	119.5		0.2	33	40	4.8	2.4	2	7.1	21	4	0.9	59	10	0.3
0.63	47.97	0.13	1.57	0.11	99.04	1315	124		0.3	34.5	55	5.2	2.6	2.2	7.5	21	4	1	60	25	0.3
0.62	48.3	0.12	1.55	0.03	99.4	1255	121		0.1	33.5	45	4.7	2.3	2.2	6.9	21	4	0.9	59.5	15	0.3
0.6	48.24	0.12	1.53	0.11	99.57	1100	99.5		0.2	33.5	50	5.7	3.2	2	6.1	17	4	1	52.5	10	0.4
0.36	58.6	0.07	1.04	0.73	99.32	1435	113		0.6	18.5	20	4.4	2.3	1.7	6.3	20	6	0.8	57.5	20	0.3
0.49	51.84	0.09	1.35	1.28	99.51	1000	96		0.4	27	45	4.5	2.4	1.8	5.8	20	5	0.9	48.5	5	0.3
0.54	53.48	0.09	1.31	1.1	98.87	1190	106.5		0.5	23	35	4.7	2.5	1.7	6.3	19	5	0.9	55	15	0.4
0.52	54.58	0.09	1.29	0.47	99.45	1205	109		0.6	23	35	4.8	2.4	1.8	6.2	20	5	0.9	55.5	15	0.3
0.85	51.3	0.11	1.4	<0.01	99.64	1660	143		0.3	26.5	40	5.2	2.9	2.3	7.4	19	5	1	74	5	0.4
0.81	52.13	0.11	1.4	<0.01	99.89	1590	140.5		0.3	26	35	5.4	3	2.2	7.1	19	6	1	73	5	0.4
0.84	51.7	0.1	1.46	0.15	99.86	1540	129.5		0.4	24.5	30	5	2.6	2.3	6.7	18	5	1	66.5	10	0.4
0.53	54.85	0.09	1.29	0.13	99.49	1225	115.5		0.6	23.5	40	4.9	2.5	1.9	6.3	20	6	0.9	60	15	0.4
0.23	48.81	0.03	1.49	<0.01	99.62	234	30.5		<0.1	48.5	50	3.5	1.9	1.1	3.9	20	2	0.7	16	<5	0.3
0.62	50.54	0.09	1.58	<0.01	99.93	694	89		0.2	33	40	4.8	2.6	1.9	5.6	18	5	0.9	42.5	10	0.4
0.33	50.55	0.06	1.35	0.09	99.47	538	52		0.1	33	65	4.3	2.4	1.5	4.8	18	4	0.9	25.5	5	0.3
0.65	49.81	0.11	1.47	<0.01	99.95	1470	147		0.3	36.5	55	5.1	2.4	2.2	7.3	20	5	0.9	75.5	10	0.3
0.4	51.42	0.06	1.41	0.04	99.5	706	67		<0.1	36.5	50	5.1	2.9	1.7	5.7	20	5	1	32.5	5	0.4
0.78	49.1	0.13	1.62	0.15	99.23	1320	132		0.1	38.5	45	5.8	2.7	2.6	8.3	18	6	1.1	58.5	85	0.4
0.33	51.03	0.05	1.36	<0.01	99.75	497	54.5		0.2	43.5	60	4.1	2.4	1.4	4.7	19	4	0.9	26.5	20	0.3
0.32	50.06	0.05	1.37	0.33	99.98	583	54.5		<0.1	45.5	55	4.2	2.6	1.5	4.9	18	4	0.9	27	20	0.3
0.55	54.71	0.09	1.3	0.11	99.54	1305	125.5		0.7	26	40	5.2	2.9	2	6.9	22	6	1	64	15	0.4
0.4	55.82	0.07	1.26	<0.01	99.72	1060	92		0.5	26.5	45	4.3	2.3	1.7	5.7	20	5	0.9	45.5	15	0.3
0.66	52.49	0.13	1.44	0.03	99.56	1210	126.5		0.3	29	30	4.9	2.6	2.2	7.4	17	5	0.9	57	15	0.3
0.39	55.16	0.08	1.27	<0.01	98.88	1035	92		0.5	27	45	4.4	2.4	1.6	5.6	20	5	0.9	45.5	15	0.3
0.38	54.95	0.07	1.29	0.37	99.38	989	86		0.5	26	45	4.2	2.3	1.6	5.3	19	5	0.8	44	45	0.3
0.49	51.93	0.1	1.29	<0.01	99.86	1075	95.5		0.3	28.5	40	4	2.1	1.7	5.6	19	4	0.8	48.5	15	0.3
0.4	50.34	0.06	1.48	0.06	99.67	606	71		0.2	34	80	4.4	2.4	1.6	5.2	20	4	0.9	35	15	0.3
0.3	61.38	0.07	0.87	1.18	99.06	1345	101		1	12.5	20	3.8	2	1.4	5.1	19	5	0.7	51.5	35	0.3
0.78	52.26	0.1	1.34	<0.01	99.5	1560	136		0.4	26.5	45	5.1	2.9	2.2	7.1	19	5	1	69.5	15	0.4
0.84	49.87	0.11	1.4	0.1	99.59	1600	139.5		0.5	30.5	45	5	2.7	2.3	7	19	5	0.9	73	10	0.4
0.69	51.98	0.13	1.43	0.38	98.92	1175	123		0.2	29	30	4.9	2.6	2.2	7	17	5	0.9	55	15	0.3

Nd	Ni	Nb	Pr	Rb	Sm	Ag	Sc	Sr	Ta	Tb	Tl	Th	Tm	Sn	W	U	V	Yb	Y	Zn	Zr
14.5	135	9	3.5	7.2	3.2	<1		293	<0.5	0.6	<0.5	1	0.3	3	5	<0.5	155	1.7	19	100	92
44	40	26	12.1	36.4	7.3	<1		739	1	0.9	<0.5	7	0.4	5	2	1.5	145	2.4	27.5	85	236
56.5	65	43	15.7	16.4	9	<1		987	2	0.9	<0.5	13	0.4	4	2	2.5	150	2.7	29.5	95	230
40.5	30	24	10.9	28	6.7	<1		731	1	0.8	<0.5	6	0.3	7	3	1	150	2.4	25.5	85	218
44.5	125	32	12.1	17	7.5	<1		784	1.5	0.9	<0.5	9	0.4	4	3	1.5	165	2.5	28.5	90	228
46.5	45	27	12.6	17	8.1	<1		1050	1.5	0.7	<0.5	6	0.3	6	2	1.5	230	2.1	23.5	80	162
39.5	70	21	10.8	22	6.6	<1		730	1	0.8	<0.5	7	0.4	4	6	0.5	160	2.5	27.5	95	199
45.5	55	27	12.3	20.6	7.6	<1		1030	1	0.8	<0.5	5	0.4	4	3	1.5	205	1.9	24.5	100	182.5
60.5	110	22	15.8	26	9.7	<1		1200	1.5	1	<0.5	4	0.4	4	3	0.5	135	2.5	28.5	80	249
51.5	40	32	13.7	15.8	8.4	<1		1215	1.5	0.9	<0.5	5	0.4	5	4	1.5	235	2.4	26.5	95	182
49	40	30	13.4	19	7.9	<1		1105	1.5	0.9	<0.5	5	0.3	3	3	1.5	220	2.1	25.5	90	176.5
50.5	40	32	13.6	15.6	7.7	<1		1180	1.5	0.9	<0.5	5	0.4	3	2	1	240	2.2	26.5	95	181
49	40	31	13.2	14.4	8.3	<1		1155	1.5	0.9	<0.5	5	0.4	4	2	0.5	230	2.1	26	105	176
40	90	30	11.3	18.8	7	<1		708	2.5	0.8	<0.5	11	0.4	5	3	1.5	160	2.8	28.5	65	190
41.5	25	20	11.6	44	6.6	<1		675	0.5	0.8	<0.5	9	0.3	4	5	1.5	100	2.1	24.5	75	229
37.5	30	22	10.3	24.6	6.3	<1		738	0.5	0.8	<0.5	6	0.4	3	3	1.5	155	2.2	24.5	80	191
41.5	35	24	11.2	30.6	6.9	<1		705	1	0.8	<0.5	7	0.4	3	1	1.5	135	2.5	25.5	80	219
41.5	35	25	11.4	31.4	7.2	<1		720	1	0.9	<0.5	7	0.4	3	3	1.5	130	2.3	26	85	230
54	55	40	15.1	14.8	8.6	<1		937	2	0.9	<0.5	12	0.4	3	2	2	135	2.6	29	90	232
52.5	55	40	14.9	16.6	8.2	<1		847	2	1	<0.5	12	0.4	4	4	2	135	2.6	28.5	95	238
49.5	55	36	13.8	18	7.9	<1		816	2	0.9	<0.5	11	0.4	4	2	2	120	2.3	27	80	218
43	45	27	11.9	32	7.2	<1		719	1.5	0.8	<0.5	8	0.4	4	5	1.5	120	2.4	26.5	85	247
15.5	135	10	3.6	7.8	3.4	<1		304	<0.5	0.6	<0.5	1	0.3	4	2	<0.5	160	1.7	19.5	105	93.5
36	110	24	9.7	20	6.2	<1		788	1.5	0.8	<0.5	3	0.4	3	2	0.5	125	2.4	26	80	251
22.5	85	11	5.9	15	4.6	<1		454	<0.5	0.7	<0.5	1	0.4	3	2	<0.5	140	2.4	24.5	85	167.5
57.5	115	40	15.8	26.6	8.8	<1		1060	2	1	<0.5	10	0.3	4	3	1.5	185	2.1	25.5	90	201
30	115	17	7.6	15.2	5.7	<1		581	0.5	0.8	<0.5	3	0.4	4	3	<0.5	135	2.6	28	85	201
58	135	24	15.5	22.2	9.8	<1		1235	1.5	1	<0.5	3	0.4	5	3	0.5	145	2.7	30	80	273
23.5	160	11	6.1	16.8	4.7	<1		515	<0.5	0.7	<0.5	3	0.4	4	3	0.5	155	2.3	24.5	85	165
24	170	10	6.3	8	4.7	<1		514	<0.5	0.7	<0.5	3	0.3	4	1	0.5	150	2.1	24.5	95	159
47	50	30	13	34	8.1	<1		789	1.5	0.9	<0.5	8	0.4	4	3	1.5	135	2.7	29	90	266
37	50	20	10	36.2	6.6	<1		622	1	0.8	<0.5	6	0.3	3	3	1	135	2.1	24	80	184
53	95	20	14.3	24.6	8.7	<1		1045	1	0.9	<0.5	4	0.4	3	2	1	125	2.2	26	70	229
36	50	20	9.8	36.2	6.2	<1		611	1	0.7	<0.5	6	0.3	3	2	1	135	2.1	23.5	75	182
34	50	20	9.3	33.8	5.6	<1		567	0.5	0.8	<0.5	6	0.4	3	2	1	130	2.1	23.5	80	182.5
37.5	50	23	10.3	22.6	6.1	<1		827	0.5	0.7	<0.5	5	0.3	3	4	1.5	180	2	21	80	158
29.5	60	17	7.8	18.2	5.3	<1		533	0.5	0.7	<0.5	4	0.4	3	3	0.5	165	2.3	25	85	157
37	35	17	10.4	55.6	6	1		537	0.5	0.7	<0.5	8	0.3	3	3	1.5	75	1.8	20.5	100	209
51	60	38	14.4	20.2	8.1	<1		844	2	0.9	<0.5	11	0.4	3	2	2	135	2.5	27.5	95	235
53	65	40	14.6	15	8.2	<1		937	2	0.9	<0.5	12	0.4	3	2	2	155	2.3	27	105	203
52.5	90	20	13.9	25.2	8.3	<1		1035	1	0.9	<0.5	4	0.3	3	2	0.5	120	2	25	70	230



Surficial deposits not shown. Cretaceous unconformities are schematic