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Mineral potential of altered rocks near Blawn Mountain, Wah Wah Range, Utah

By

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MINERAL POTENTIAL OF ALTERED ROCKS NEAR BLAWN MOUNTAIN, WAH WAH RANGE, UTAH

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ABSTRACT

A mineralized area near Blawn Mountain in the southern Wah Wah Range has potential for deposits of lithophile metals, including uranium, tin, molybdenum, and beryllium. An area of iron oxide, alunite, and kaolinite alteration in rhyolite on Blawn Mountain overlaps southward with an area of fluorite, montmorillonite, and illite alteration in rhyolite and breccia near the Staats mine. The area on Blawn Mountain is largely depleted of metals other than iron, but the area near the Staats mine has produced some fluorspar and uranium and has anomalous amounts of tin, molybdenum, and beryllium in altered rock. Topaz rhyolites near the Staats mine and on The Tetons are similar to those in the Thomas Range of Utah, which are associated with deposits of fluorspar, uranium, and beryllium. Unmineralized topaz rhyolite in the Wah Wah Range contains anomalous traces of Be, Ga, Li, Mo, Nb, and Sn. Extensive areas of jasperoid with very low trace metal contents are associated with the areas of mineralization and alteration.

The age of alteration and mineralization in the southern Wah Wah Range can be inferred from the age of host rocks. The rhyolite of Blawn Mountain, which is the host for alunite and kaolinite, is dated as 30.7 ± 1.5 m.y. old. The intrusive topaz rhyolite of the Staats mine area, which with its altered breccia zone is the host and

probable source of fluorine and lithophile metals, is 19.7 ± 0.8 m.y. old. The overlap of both kaolinite and montmorillonite in altered breccia along the north side of the intrusive topaz rhyolite suggests that all of the alteration and mineralization may be younger than 19.7 ± 0.8 m.y.

INTRODUCTION

The Blawn Mountain area (fig. 1) in the southern Wah Wah Range has attracted exploration for alunite, kaolinite, fluorspar, and uranium, with some production of the latter two (Thurston and others, 1954; Whelan, 1965). It borders the southern edge of an area where large alunite deposits have been reported (Parkinson, 1974). All of these mineral occurrences lie within the Pioche mineral belt (Shawe and Stewart, 1976) and along the Blue Ribbon lineament (Rowley and others, 1978). New evidence presented in this report indicates potential for resources of beryllium, molybdenum, and tin as well as uranium and fluorspar in the southern Wah Wah Range.

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GEOLOGY

The area south of Blawn Mountain contains thrust sheets of Paleozoic rocks (Miller, 1966) that have an overall synclinal structure and are cut by numerous northerly-trending high-angle faults and a few easterly-trending tear faults (fig. 2). Ash- flow tuffs of Oligocene age overlie the Paleozoic rocks and are in turn unconformably overlain by silicic volcanic rocks of Miocene age. A region of extensive brecciation and hydrothermal alteration that corresponds to the Blue Ribbon lineament (Rowley and others, 1978) passes through rhyolitic ash-flow tuff on Blawn Mountain. The following sections describe the rocks of the area and the effects of hydrothermal alteration in more detail.

Rocks of Paleozoic Age

Four units are readily distinguished in the Paleozoic terrane south of Blawn Mountain; they are the Ordovician Eureka Quartzite, undifferentiated Ordovician to Devonian dolomite, a lower unit (carbonate rocks) of Mississippian age, and an upper unit (sandstone-bearing) of Mississippian age. The Eureka Quartzite (45-90 m thick) is well exposed southwest of Blawn Mountain (fig. 2), where it is the only easily recognized marker in the lower part of the Paleozoic section. A pink, vitreous thick- to medium-bedded orthoquartzite, the Eureka contains conspicuous rounded quartz grains that permit it to be readily distinguished from nearby bodies of jasperoid, which it superficially resembles. The Eureka is brecciated and contains iron oxide minerals where it crosses the crest of Blawn Mountain, and fragments of Eureka are the sole constituent of a probable breccia pipe 1.5 km southwest of Blawn Mountain. About 750 m of Ordovician to Devonian dolomite (undifferentiated) conformably overlies the Eureka Quartzite. The dolomite was not further divided for this study, but Miller (1966) mapped the Upper Ordovician Fish Haven Dolomite, the Middle and Upper Silurian Laketown Dolomite, the lower Devonian Sevy Dolomite, and the Middle Devonian Simonson Dolomite in part of the area. Extensive areas of jasperoid occur in the dolomite and small veinlets of clear dolomite, iron oxide minerals, quartz, and calcite are numerous. Rocks of Mississippian age conformably overlie the dolomite and are divislble into a lower unit consisting of about 210 m of gray limestone and dolomite and an upper unit of about 550 m of sandstone, limestone, and dolomite (Miller, 1966). Only the lowermost 120 m of the upper unit (mostly brown sandstone) is present in the mapped area owing to thrust faulting.

Rocks of Tertiary age

Four units of Tertiary igneous rocks were mapped in the area: (1) Oligocene Needles Range Formation, (2) Oligocene rhyolitic ash-flow tuff on Blawn Mountain, (3) water-laid tuff of probable Miocene age that unconformably overlies the Needles Range Formation, and (4) topaz rhyolite of probable Miocene age.

Pink-gray to dark red-brown ash-flow tuff of the Oligocene Needles Range Formation crops out in the low hills south of Blawn Mountain, where it unconformably overlies Paleozoic rocks. Most of the formation is densely welded ash-flow tuff with conspicuous feldspar phenocrysts; it probably corresponds to the Wah Wah Springs Tuff Member (Best and others, 1973). Pink-red crystal tuff with abundant plagioclase, quartz, and biotite crystals and scattered pumice occurs in the upper part of the Needles Range Formation southwest of the Tetons; it is probably the Lund Tuff Member (Best and others, 1973). The average K-Ar age of the Needles Range has been estimated at 29.7 ± 0.9 m.y. (Best and others, 1973; Armstrong, 1970).

Rhyolite of Oligocene age crops out extensively on Blawn Mountain and to the northeast, where it is the host for major alunite alteration. The rhyolite of Blawn Mountain was not observed in contact with the Needles Range Formation, but it probably overlies the Needles Range Formation north of the mapped area (Taylor, 1959). Abundant quartz phenocrysts and altered grains that may have been feldspar and pumice in a fine-grained matrix are all that remain of the original rock, which was probably an ash- flow tuff. The rhyolite has been extensively brecciated and altered by hydrothermal fluids to kaolinite, alunite, and silicified breccia. An age of 30.7 ± 1.5 m.y. was determined on zircon by the fission track method, indicating an age very close to that of the Needles Range Formation.

Tan vitric tuff and tuffaceous breccia as much as 30 m thick locally overlies the Needles Range Formation. The crudely stratified tuff is composed of vitric pumice and shards of the same chemical composition as the overlying rhyolite and lesser quantities of volcanic rock fragments and broken crystals of plagioclase, quartz, and biotite derived from the underlying Needles Range and perhaps other formations as well. The evidence for erosion of the Needles Range Formation indicates an unconformity at the base of the tuff; the upper contact is conformable with the overlying topaz rhyolite.

Pink to light gray topaz rhyolite of probable Miocene age crops out on hill 7715 near the Staats mine, on The Tetons, and on hill 7169. The rhyolite near the Staats mine occurs as a small plug that has an outer brecciated zone of altered rhyolite and dolomite fragments. The rhyolite contains steeply dipping flow foliation that suggests an eruptive source near the center of the outcrop (Whelan, 1965). Topaz rhyolite at The Tetons conformably overlies water-laid tuff and contains conspicuous flow foliation that is conformable near the base but varies considerably in attitude near the top. These characteristics suggest that it is a flow formed by venting of the intrusive topaz rhyolite. Both rhyolites contain sparse phenocrysts of quartz, sanidine, plagioclase, and brown biotite in a groundmass of potassium feldspar and quartz, and both contain small amounts of topaz and fluorite in cavities and in the groundmass. An age of 19.7 ± 0.8 m.y. is indicated by a K-Ar date on sanidine from fresh intrusive rhyolite near the top of hill 7715 (Rowley and others, 1978).

DESCRIPTION OF ALTERED AREAS

There are two main areas of alteration: (1) altered rhyolite on Blawn Mountain contains alunite, kaolinite, iron oxides, and silicified breccia, and (2) altered breccia surrounding intrusive topaz rhyolite contains fluorspar, kaolinite, illite, and montmorillonite. Lateral changes in mineral content indicate that the two altered areas are continuous or overlap in breccia next to intrusive topaz rhyolite north of the Staats mine. Also, many bodies of jasperoid are scattered in dolomite east and south of the intrusive topaz rhyolite.

Altered breccia on Blawn Mountain

The Oligocene rhyolite is extensively brecciated and silicified for more than 1.5 km along the crest of Blawn Mountain. This brecciated zone is next to an east-west fault that follows the Blue Ribbon lineament of Rowley and others (1978). The breccia contains relict quartz phenocrysts scattered in a matrix of fine-grained quartz, disseminated hematite, and trace amounts of barite. It grades northward into silicified rhyolite containing kaolinite and alunite and southward to an area of kaolinite and iron oxide alteration along small faults that cross the dolomite-rhyolite contact on Blawn Mountain. These faults post-date the main period of brecciation there. Study of samples taken across two faults (Localities BL-A and BL-B on fig. 2) showed the same sequence from dolomite to rhyolite: (1) dolomite with increasing brecciation and iron oxide veinlets toward the fault, (2) as much as 1 m of nearly pure iron oxide replacing fault breccia, (3) about 10-12 m of nearly pure kaolin replacing rhyolite breccia, and (4) grading into silicified rhyolite breccia. The iron oxide veins contain mostly hematite and magnetite with a trace of fluorite, and they are anomalously radioactive. Euhedral grains of hematite after magnetite are dispersed in the kaolinite near the iron oxide veins. Whelan (1965) reports nearly pure alunite replacing rhyolite adjacent to some of the iron oxide occurrences.

Altered breccia at the Staats mine and vicinity

Altered breccia occurs around the margins of intrusive topaz rhyolite at the Staats mine and vicinity (Whelan, 1965). Prospecting and some mining for uranium and fluorspar have been conducted in the breccia zone. The breccia was formed by intrusion of the rhyolite, so that, in the northern part of the breccia zone, one passes from dolomite country rock into (1) brecciated dolomite, (2) breccia with altered dolomite clasts, (3) breccia with altered rhyolite clasts, and (4) partly altered and fresh rhyolite. The clasts in breccia around the southern part of the intrusive are mainly altered rhyolite.

Most of the breccia and some of the intrusive rhyolite are altered to clay minerals. X-ray diffraction studies showed that montmorillonite, kaolinite, and illite are common, but kaolinite is abundant in the northern part of the breccia zone (localities ST-A and ST-B) and illite occurs mainly in the southern part (localities ST-C and ST-D). Locally the breccia is replaced by fluorite, quartz, and calcite. Uraninite and several secondary uranium minerals have been identified in the breccia (Whelan, 1965). The breccia zone is anomalously radioactive throughout its extent; testing with a scintillation counter showed that some, but not all, of the radioactivity is associated with fluorite.

Cassiterite was identified in altered breccia from the northeast part of the intrusive rhyolite (Locality ST-A). The cassiterite occurs as light brown, euhedral grains in a matrix consisting almost entirely of kaolinite and fluorite. The area of occurrence is only about 2 meters across; three samples from the occurrence contained 300, 500, and 3,000 ppm tin. Only trace amounts ($\leq$ 20 ppm) of tin were found in samples of breccia nearby.

Jasperoid

Jasperoid occurs in brecciated dolomite along many ridge tops south of hill 7715 and adjacent to faults and the intrusive topaz rhyolite. The jasperoid was mapped as Eureka Quartzite by Miller (1966), but field and thin section study revealed no evidence for a sedimentary origin. It is typically pink and weathers to rustycolored outcrops that tend to be resistant to erosion. The brecciated nature of the jasperoid is evident at many outcrops, and careful search failed to reveal any evidence of bedding. The distribution of jasperoid is very irregular, and its contact with neighboring dolomite is irregular instead of conformable. Jasperoid partially replaces dolomite and veinlets of jasperoid crosscut dolomite at some localities, giving further evidence of the replacement origin of the rock.

The jasperoid, when viewed under the microscope, consists almost entirely of granular quartz. Breccia fragments generally are composed of very fine-grained, microcrystalline and, less commonly, radiating quartz. These fragments are set in a matrix of fine to coarse granular quartz that contains numerous veinlets and cavities filled with coarsely crystalline quartz. Cockscomb structure is a common feature of the vein and cavity fillings. Hematite and late calcite fill the interiors of some veinlets and the interstices of quartz grains. No rounded grain outlines or other evidence for detrital origin was observed in any of the quartz. In the jasperoid, quartz of sand size tends to have straight, interlocking grain boundaries and straight extinction, or nearly so. Small inclusions of carbonate minerals fill quartz grains in some of the jasperoid, thus also supporting an origin by replacement of dolomite.

GEOCHEMICAL ANOMALIES

The topaz rhyolite was the locus of uranium and fluorine mineralization that also introduced traces of numerous metals near the Staats mine area (table 1). The topaz rhyolite (both extrusive and intrusive) contains anomalous traces of such lithophile metals as Be (7-15 ppm), Ga (20-50 ppm), Li (as much as 130 ppm), Mo (as much as 70 ppm), Nb (70-150 ppm), and Sn (10-15 ppm). Anomalous amounts of these metals occur also in the breccia zone near intrusive topaz rhyolite; especially noteworthy are widespread Li (as much as 230 ppm), Mo (as much as 150 ppm), and the Sn in cassiterite discussed earlier. Trace amounts of Cr (as much as 70 ppm), Pb (as much as 300 ppm), and V (as much as 200 ppm) occur in the breccia, also.

The altered rhyolite breccia on Blawn Mountain and the widespread jasperoid in dolomite are notably deficient in most metals (table 1). The iron veins in Blawn Mountain contain anomalous Be (7-20 ppm) as well as expectable amounts of Co (250 ppm), Cu (as much as 100 ppm), Mn (2,000-3,000 ppm), Ni (15-300 ppm), and Zn (300-1,500 ppm). Both the altered rhyolite on Blawn Mountain and the jasperoid were analyzed for gold; none was found even though the lower limit of detection was 0.05 ppm.

DISCUSSION AND CONCLUSIONS

The surface alteration and metal anomalies associated with topaz rhyolite and breccia near the Staats mine indicate potential for deposits of beryllium, molybdenum, and tin, as well as uranium and fluorspar. Reconnaissance in southwestern Utah (Rowley and others, 1978; Shawe and Stewart, 1976) indicates that the area may be part of a major mineral belt comparable to the beryllium belt that extends from the Sheeprock Range of Utah into Nevada (Cohenour, 1963).

The association in the southern Wah Wah Range of uranium and fluorspar deposits with topaz rhyolite and hydrothermally altered breccia that contains carbonate clasts indicates an environment of ore deposition somewhat comparable to that at Spor Mountain, Utah. There, uranium, lithium, and fluorine occur in large low-grade beryllium deposits in water-laid tuffaceous breccia that contains carbonate clasts (Lindsey, 1977). A major difference between the Wah Wah occurrence and the Spor Mountain deposits is the higher acidity of the hydrothermal solutions that affected the former.

The occurrence of tin in altered breccia near the Staats mine is somewhat comparable also to tin occurrences in Mexico (Ypma and Simons, 1969). Mineralized rhyolite breccia in Durango, Mexico, contains about 0.4 percent tin as both wood tin and honey-colored cassiterite. The Mexican tin deposits also contain mimetite, an antimony mineral, and native bismuth, in contrast to the tin occurrence near the Staats mine. Cassiterite also occurs in stockwork molybdenum deposits, as is well known at Climax, Colorado (Wallace and others, 1968) and in Mexican examples also (Randall, 1975).

The contrasting effects of hydrothermal alteration at Blawn Mountain and the Staats mine were caused by either (1) alteration along a pH gradient, or (2) by two separate episodes of hydrothermal activity. An area of very acidic alteration on Blawn Mountain is characterized by alunite, kaolinite, iron, silicified rock, and very low trace metal content outside the iron veins. This area grades southward into an area of alteration by neutral to alkaline solutions near the Staats mine that is characterized by montmorillonite and high trace metal content. The change in alteration is transitional, as can be seen by the occurrence of both montmorillonite and kaolinite in the breccia zone around the north side of the intrusive topaz rhyolite. Whether the transition is due to a pH gradient or to the overlapping influence of two hydrothermal events is not known. Both kaolinite and montmorillonite alteration post-date the 19.7 m.y.-old intrusive topaz rhyolite. Silicified rhyolite and jasperoid replacing dolomite probably represent deposition of fugitive silica from the areas of argillic alteration.

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Figure 1.--Index map of the Blawn Mountain area, Wah Wah Range, Utah

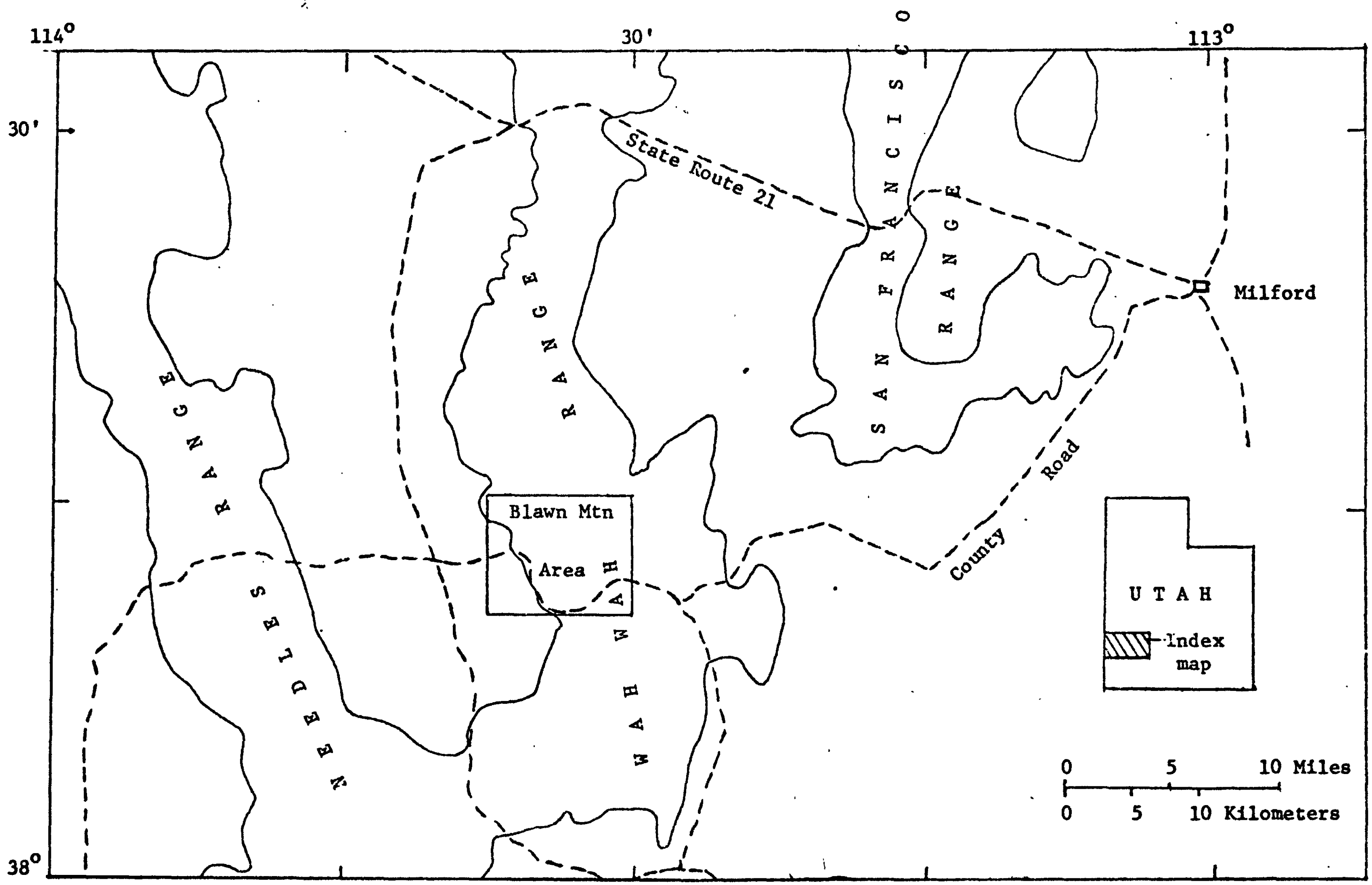

Figure 2

EXPLANATION

Tertiary

- **Miocene**
  - Ttr — Topaz rhyolite (Pink porphyritic rhyolite)
  - Tvt — Water-laid tuff (Tan Vitric tuff and tuffaceoua breccia)

Unconformity

- **Oligocene**
  - Tr — Rhyolite (White ash-flow tuff; hydrothermally altered)
  - Tnr — Needlea Range Formation (Maroon porphyritic ash-flow tuff)

Unconformity

Mississippian

- Mu — Upper unit (Brown sandstone and gray dolomite)
- Ml — Lower unit (Gray limestone and dolomite)

Devonian to Ordovician

- DOu — Undifferentiated dolomite (Dark gray dolomite)

Ordovician

- Oe — Eureka Quartzite (Pink orthoquartzite)

Area of silicified breccia

High-angle fault, dashed where inferred (ball and bar on downthrown side)

Thrust fault (sawteeth on upper plate)

Contact, dashed where inferred

Strike and dip of bedding

X ST-A Age

Location of samples for geochemical analysis and age dates

Table 1.--Range of chemical composition for altered rock, dolomites and associated jasperoids, and topaz rhyolite from the Blawn Mountain area

[Analyses by six-step semi-quantitative spectrographic method by J. C. Hamilton and L. A. Bradley; sample groups 5,6,7,8,9,10 and 13 analyzed for Li by J. C. Hamilton; equivalent uranium (eU) by beta-gamma scaler by E. J. Fennelly and G. O. Shipley; sample groups 1,2,3,4,6,11,12 and 14 were analyzed for Au by fire assay and atomic absorption by W. D. Goss and G. D. Shipley; all were below 0.05 ppm. Elements looked for but not found in any sample, with their lower limits of detection in parts per million, are Ag (0.5), As (1000), Au (70), Cd (20), Eu (100), Ge(10), Hf (100), In (10), P (2000), Pd (1), Pt (30), Sb (150), Ta (200), Te (2000), Th (200), Tl (50), and W (100). N, not found; L, present but less than lower limit of detection; B, samples not analyzed.]

	Lower Limit of Detection	1	2	3	4	5	6	7	8	9	10	11	12	13	14
								Chemical composition in weight percent							
Si	0.002	0.03-0.07	0.2-2.0	>10	>10	0.03-1.0	7.0->10	5.0->10	>10	>10	0.5-7.0	L-0.5	>10	>10	>10
Al	.001	0.02-0.1	0.5-1.0	10.0->10	0.3-0.5	0.02-1.0	1.5->10	7.0->10	5.0-7.0	10.0	1.5-10.0	L-0.07	0.15-0.3	7.0-10.0	7.0
Fe	.001	0.15-0.5	7.0->10	0.7-5.0	0.02-0.3	0.03-0.5	0.5-1.0	0.7-5.0	0.7-1.0	0.7-1.5	0.07-1.5	0.015-0.1	0.01-0.3	0.5-0.7	0.7
Mg	.002	5.0-7.0	0.1-0.7	0.02-0.05	0.03-0.05	3.0->10	0.2->10	0.03->10	0.7-1.5	1.5-3.0	0.03-0.5	3.0-10.0	0.015-0.2	0.05-0.15	0.05-0.15
Ca	.002	7.0->10	1.0->10	0.03-0.15	0.15-0.2	10.0->10	0.2->10	0.7->10	0.1-0.2	0.5-7.0	>10	7.0->10	0.02-0.5	0.3-0.5	0.3-0.5
Na	.05	0.05	L-0.07	0.07-0.3	L-0.05	N-0.07	N-0.1	N-0.3	0.15-0.3	0.2-1.5	N-L	0.05-0.07	L	3.0-5.0	3.0
K	.7	N	N	N	N	N	N-3.0	N-3.0	3.0	3.0-5.0	N-3.0	N	N	3.0-5.0	3.0
Ti	.0002	L-0.002	0.005-0.007	L-0.015	0.3-1.0	N-0.015	0.01-0.15	0.01-0.15	0.03-0.15	0.1-0.15	0.01-0.15	N-0.001	0.001-0.01	0.03-0.05	0.03-0.15
								Chemical composition in parts per million							
B	20	N	N	N-L	L	B	N-30	N-30	N	N	N	N	L	N-L	L
Ba	1.5	3-10	15-100	15-300	30-200	5-150	5-150	30-200	15-30	200-500	5-200	2-3	30-150	15-30	10-20
Be	1	N	7-20	N-1.5	N	N-1.5	1.5-7	1.5-15	5-7	7-15	1.5-7	N	B	7-10	7-15
Bi	10	N	N	N	N	B	N-10	N	N	N	N-15	N	N	N	N
Ce	150	N	N	L-200	N	N	N-L	N-L	N-L	N-L	N	N	N	N-L	L
Co	3	N-L	7-30	N	N	B	N-7	N	N-7	5-7	N-L	B	N	N	N
Cr	1	2-3	2-3	15-70	2-7	1.5-7	5-70	1-50	3-7	7-20	15-70	2-3	L-1.5	N-3	1-2
Cu	1	1.5	1.5-100	7-100	L-7	1.5-5	1.5-50	1.5-30	1.5-7	5-7	1-7	L-3	L-7	N-1.5	L
Ga	5	B	N	7-100	N	N-7	7-70	15-50	30	20-30	5-15	B	N	20-50	30
La	30	B	N	50-100	N-L	N	N-100	N-L	L	N-50	N-70	N	N	L-50	L-50
Li	50	N	N	N-150	N	5-29	10-230	13-65	43-67	42-80	N-45	B	N	62-130	L-100
Mn	1.0	150-1500	2000-3000	3-7	30-300	50-1000	15-1300	7-150	50-150	150-700	3-150	30-70	5-30	300-500	300-700
Mo	3	N	N	15-70	N-5	N-10	N-20	N-150	7-70	N	10-150	N-7	N-3	N	7-70
Nb	10	N	N-L	B	15-50	B	N-100	N-100	70-100	70	N-50	N	B	70-100	100-150
Nd	70	B	B	70-200	N	B	N-70	N-70	70	70	N	B	B	70	N-L
Ni	5	L-7	15-300	L-10	N-L	N-7	N-30	N-15	N-10	5-7	N-7	L	L-7	N-L	L
Pb	10	B	N-10	10-15	N-15	N	15-150	N-70	15-50	30-70	N-300	N-10	N	20-70	50
Sc	5	N	N-150	N-30	L-15	B	N-10	N-15	N	N-7	N-7	N	N	N	N-L
Sn	10	N	N	N	B	N	N-500	N-15	10	10	N-3000	B	B	10-15	N-15
Sr	5	10-15	15-30	70-300	7-15	15-70	7-130	7-70	7-10	30-100	7-70	7-30	N-5	10-30	10-15
eU	10	L	L-30	L-20	L-10	L	L-90	10-80	50-250	30-140	20-70	L	L	40-60	40-50
V	7	N-7	10-150	100-200	L-20	N-20	7-200	N-150	15-20	30-70	30-150	N-10	L-10	N-L	L
Y	10	N-15	15-100	N-70	L-20	N-10	30-150	15-100	30-70	30-70	N-200	N	N	50-100	20-50
Yb	1	N-L	B	N-5	L-2	N-1	2-10	1.5-10	5-7	7	N-7	B	B	7-10	3-7
Zn	200	B	300-1500	N	B	B	N	N	N	N	N	B	N	B	N
Zr	10	B	B	B	150-700	N-15	15-150	N-150	100-150	100-150	N-200	N	B	100-150	100

Localities and sample descriptions

1. Blawn Mountain iron-kaolinite prospects (BL-A and BL-B): altered dolomite breccia (4 samples)
2. Blawn Mountain iron-kaolinite prospects (BL-A and BL-B): iron oxides (3 samples)
3. Blawn Mountain iron-kaolinite prospects (BL-A and BL-B): kaolinite (4 samples)
4. Blawn Mountain iron-kaolinite prospects (BL-A and BL-B): silicified rhyolite porphyry (3 samples)
5. Staats Mine and associated uranium-fluorspar prospects: brecciated dolomite (5 samples at localities ST-A and ST-D)
6. Staats Mine and associated uranium-fluorspar prospects: argillized breccia at locality ST-A (10 samples)
7. Staats Mine and associated uranium-fluorspar prospects: argillized breccia at locality ST-B (8 samples)
8. Staats Mine and associated uranium-fluorspar prospects: argillized breccia at locality ST-C (5 samples)
9. Staats Mine and associated uranium-fluorspar prospects: argillized breccia at locality ST-D (5 samples)
10. Staats Mine and associated uranium-fluorspar prospects: argillized breccia with ≥90% CaF_2 (6 samples from localities ST-A and ST-B)
11. Dolomite country rock (11 samples)
12. Jasperoid in country rock (8 samples)
13. Intrusive topaz rhyolite (6 samples)
14. Extrusive topaz rhyolite (4 samples)